CHAPTER 2. EXISTING CONDITIONS IN THE SAMMAMISH RIVER CORRIDOR

As a result of historical and recent events, current conditions in the Sammamish River Corridor are severely degraded and have resulted in a decline in many fish and wildlife populations. Aquatic habitat area has been reduced by more than half (as estimated by the change in river length; originally ~30 miles, now less than 14 miles in length), and the remaining channel was designed to have a uniform width and gradient (eliminated pools and riffles). Native plant communities are rare in the corridor and are completely changed from the historic forested swamp conditions. Typically, the only native fish species doing well in the river are often adaptable to altered conditions, such as cutthroat trout. However, it appears no native fish species have yet become extinct in the Sammamish sub-watershed (although there may have been a spring chinook stock in the subwatershed which no longer exists), although many wildlife species have been extirpated[3]. Alterations have caused adverse impacts on native salmon populations in particular. A total of seven salmon species are known to be present in the north Lake Washington watershed, and of those, two are listed as threatened (chinook, bull trout), one has been petitioned for listing as endangered (kokanee), three are considered depressed by WDFW (coho [listed as a candidate species under ESA], steelhead, and sockeye), and one has unknown status although it is considered "not warranted" for listing under the ESA (coastal cutthroat) (NOAA 2000; USFWS 2000; WDF 1993; Kerwin 2001).

Of particular importance to native fish and wildlife species, natural watershed processes have been disrupted. Watershed processes naturally create and rework habitat features over time and historically exerted natural selection forces on the fish and wildlife populations in the watershed. Watershed processes crucial to proper ecological functioning include the following: (1) routing and delivery of water, sediment, and LWD; (2) cycling of nutrients and carbon; and (3) heat balancing (Gersib, *et al*. 2001).

As previously discussed, routing and delivery of water has been significantly altered in the Greater Lake Washington Watershed by the lowering of Lake Washington, the deepening of the river channel, water withdrawals, and a significant increase in impervious surface area, which increases peak flow and decreases base flow. The Sammamish River likely never transported a significant quantity of coarse sediment, but the channel deepening and armoring has eliminated native substrate and reduced bank sediment sources. Fine sediment deposition has increased in tributary streams and their deltas. LWD is currently almost non-existent in the river due to removal before and during the deepening project, in addition to a lack of riparian trees for recruitment along the mainstem and in the tributaries. The riparian area is not forested and is now dominated by non-native grasses and shrubs (or development), and channelization has eliminated erosion and meandering processes necessary to recruit what little adjacent wood does exist. Stormwater runoff is delivered directly to the river in a number of locations, causing increased levels of nutrients and other pollutants (particularly bacteria and other contaminants). In addition, few wetlands exist within the valley to retain contaminants. The heat balance throughout the river has been significantly altered from natural conditions as a result of reduced base flow, increased groundwater withdrawal, and lack of a functional riparian area. In short, all watershed processes have been degraded to a greater or lesser extent in the Sammamish River Corridor. Degradation of natural processes has a profound influence on the quantity and quality of aquatic and terrestrial habitats as described below.

FLOODPLAIN AND RIPARIAN VEGETATION

Riparian vegetation has been removed or altered over a significant portion of the corridor, and in many areas revegetation is constrained by urban development, developed parks and golf courses, or agriculture (Jeanes

[3] Pink and chum salmon likely historically occurred in the Cedar River, but no longer occur likely as a result of the diversion of the Cedar River into Lake Washington.

and Hilgert 1999). Generally, the vegetated riparian area along the river is less than 50 feet (15 m) wide with very few trees. In many areas, vegetation is nonexistent, having been replaced by parking lots, agricultural fields, and paved trails. In areas where vegetation is present, it is primarily comprised of non-native species. Jeanes and Hilgert's (1999) habitat survey shows reed canary grass and Himalayan blackberry dominate the plant community in most reaches, although overall percent cover was not determined (see reach maps, Figures 5-11). Riparian vegetation loss leads to several problems in a stream system, including elevated water temperatures, increased bank erosion, decreased LWD recruitment, decreased insect and detrital inputs, and decreased instream cover. A loss of riparian cover may lead to decreased fish survival and production, since terrestrial insects that colonize riparian vegetation can comprise a significant portion of the fish diet (Higgs, *et al* 1995). Direct shading of the river can, in some cases, reduce water temperature and prevent temperature increases associated with solar radiation. However, in the case of the Sammamish that is now a single, much wider channel, riparian shading can generally only provide slight cooling because the wide width of the river prevents complete shading and the volume of water is quite large (the historic channel was composed of narrower braided channels). Of equal importance is loss of wetland habitat in the floodplain, which has likely resulted in reduced groundwater recharge, and subsequent loss of discharge to the river. Groundwater withdrawals in the floodplain may also have reduced groundwater discharge to the river (King County is currently studying this issue).

As a result of the deepening project, the Sammamish River floodplain has been significantly diminished in many areas. While reduced flooding results in less damage to human structures and activities, it also significantly reduces wetland habitat, groundwater recharge, LWD recruitment, and creation of new aquatic and floodplain habitat. Most of the valley floor is now devoted to agricultural and urban land uses (including golf courses and maintained playing fields). These areas provide only minimal wildlife habitat. A few small native plant communities remain (although non-native species are rapidly encroaching): in Marymoor Park, across from the Willows Run Golf Course, at Blythe Park, at Swamp Creek, and at the island at the mouth of the river. A few newly restored or revegetated areas also exist in Redmond, Woodinville, and at the confluence with North Creek. However, these natural or semi-natural areas comprise less than 10% of the former floodplain area. Essentially no off-channel habitat exists since completion of the deepening project, and the river has very little capability to form these habitats due to its gradient, the deepened channel, and bank armoring. All former oxbows and sloughs are either cut off by elevation or have been filled in. Some wetland habitat still exists, primarily in Kenmore, Woodinville and Marymoor Park, but most wetlands are not connected to the river except during floods above the design flow (40 year spring flood). Most of the existing wetland areas contain the following plant communities: emergent or scrub-shrub with willow, spirea, and reed canary grass as common dominant species (Shannon & Wilson 2001). It appears that only about 150 acres [60 hectares] of wetland remain in the corridor (since many parts of the historic valley were wetland, the historic acreage was likely more than 3000 acres [1200 hectares]).

HYDROLOGY

The current configuration of the straightened channel was designed to convey a 40-year spring flood event (after March 1, approximately a 10-year annual event, ~2,200 cfs) and has further shortened the channel length to approximately 13.7 miles. Sources vary regarding the actual length of the channel. Depending on where the end points are designated, the length ranges from 12.8 to 15.3 miles (Jeanes and Hilgert 1999; King County SWMD 1993; Kerwin 2001; PNWRBC 1969). For the purpose of this report, we will consider the length of the river to be 13.7 miles (21.9 km) based on measurements on USGS topo maps from the western tip of the island at the mouth (Lake Washington) to 3,000 feet (909 m) upstream of the weir (Lake Sammamish). Extreme flows (100-year low and high flows) in the Sammamish River range from approximately 10 cfs (at the weir) to more than 4,000 cfs (at Woodinville). Frequent summer low flow conditions are approximately 30 to 40 cfs (at the weir), and winter high flows (2-yr event) are approximately 1,500 cfs (at Woodinville). (All flow data is from ACOE frequency data, from staff and flow gage records at the weir and Woodinville). Of particular note is that many of the lowest flows on record have occurred since 1985. This is likely due to a combination of factors including reduced low flow associated with development

impacts and increased surface and groundwater withdrawals, and possibly some lesser effects from decadal climate oscillations in the eastern Pacific Ocean and global climate change. Lower summer base flow creates an opportunity for increased heating (temperature increases) of the river due to a lower volume of water. A number of entities have water rights to withdraw groundwater or surface water for residential, agricultural, and municipal and industrial uses. These water right holders include several water purveyors, Marymoor Park, farmers, golf courses and others.

As previously discussed, the channel was deepened and widened for the express purpose of preventing spring flooding and high water table conditions on agricultural lands in the floodplain. The channel deepening reduced the frequency of overbank flow, lowered the groundwater table, and disconnected off-channel habitat from the river. Natural off-channel habitat has essentially been eliminated. Furthermore, although a few channels are connected to the river, they are primarily irrigation ditches. The channel-deepening project excavated beneath the alluvial sediments into lower soil layers of glacial outwash and glacial till (King County Memo, 1964). Following the deepening, several adjacent landowners complained their wells had gone dry or were nearly dry (King County Memo, 1964). This would be expected if the original groundwater table was in direct connection with the river and was lowered by 5 to 10 feet. Subsequent investigations indicated the groundwater table *was* lower than the river elevation in some areas (King County Memo, 1964; Metropolitan Engineers, 1972), possibly due to seasonal withdrawal of groundwater for irrigation. The Corps also noted that the groundwater table was lower than the elevation of Bear Creek in geotechnical investigations in 1996 near Bear Creek in Redmond (Corps geotechnical data, 1996).

The backwater condition that occurs due to the seasonal fluctuation of Lake Washington water levels has also been significantly changed. Historically, water levels of Lakes Washington and Sammamish would have been lowest in late summer resulting in the lowest influence of Lake Washington backwater conditions during this period. The Lake Washington water level is currently regulated by the Corps to provide some flood control benefit, as well as water supply for navigation and fish passage at the locks. The Lake elevation is strictly controlled with an average 2-foot (0.6 m) fluctuation over the year. Lake Washington is maintained at its lower level (13 feet NGVD) during the winter months (November through March) and raised to the higher level (15 feet NGVD) during spring to provide sufficient water throughout the typically dry summer season. In very dry years, the lake elevation may be drawn down to low water (13 feet NGVD) conditions by August or September. This reverse high summer and low winter elevation changes the natural flow dynamics in the Sammamish River. The high summer lake elevation causes backwater conditions in the Sammamish River up to approximately RM 3 (4.8 km). The backwater condition significantly slows river velocity (Jeanes & Hilgert [1999] measured average velocity below RM 3 at 0.2 fps or less) and may contribute to elevated temperature as a result of solar heating. However, even the lowest historical Lake Washington water levels were typically higher than current lake levels (see page 6). This would have caused a backwater effect even during the summer months, although the channel was far more braided and shaded by mature trees.

AQUATIC HABITAT

An aquatic habitat survey was recently conducted by R2 Resource Consultants (Jeanes & Hilgert 1999) to define and quantify the aquatic habitats present in the mainstem Sammamish River. The methodology used for this survey was the Timber-Fish-Wildlife Ambient Monitoring Program (Northwest Indian Fisheries Commission 1994), which has been used on many streams and rivers in Washington. The mainstem Sammamish River between Lakes Sammamish and Washington is comprised of 98% glide habitat (Jeanes and Hilgert 1999). Riffles make up 1.4% of habitat and only two pools that meet the Timber-Fish-Wildlife

criteria[4] (1994) were identified (0.4%) on the mainstem. Riffles and pools provide rearing habitat and appropriate prey organisms for some juvenile salmon (coho, steelhead). The lack of these habitats has further reduced the value of the mainstem for juvenile salmon. Velocity in the river typically averages less than 0.5 feet per second (0.15 meters per second) in this glide-dominated system.

Another recent study, using ultrasonic telemetry to determine adult chinook migration timing and behavior identified and mapped a total of 29 "pools" in the Sammamish River (Fresh *et al* 1999) that were utilized by adult salmon for holding on at least one occasion. These "pools" were not identified using any standardized methodology, but are based on visual observation that they are deeper than adjacent channel areas. Overall, pools are necessary for juvenile rearing and refuge and as adult holding areas for upstream migration. Fresh *et al*. (1999) reported that tagged adult chinook moving through the Sammamish River during the warm 1998 summer/fall season were only detected in pools or other deep areas or near overhanging vegetation[5]. Residence time for chinook in a single pool was as long as 24 days. It is likely they were holding in the relatively deeper water because of slightly cooler water temperatures (water quality measurements as part of the study in 1998 indicated that temperatures were up to 3.6 F [2° C] cooler at the bottom of "pools" than at the surface of the river) and/or a preference for cover from predators (depth can serve as cover in some situations and coho and other salmon have been observed migrating quickly through riffles and holding in deep pools both for resting and cover [Sandercock 1991]). In the cooler year of 1999, tagged chinook also remained in pools for up to several days (data not fully analyzed yet). Total average time spent in the river for tagged chinook was approximately 9 days in 1998 versus 7 days in 1999, possibly indicating they spend less time in the river or "pools" when temperatures are cooler, although not enough statistical analysis has been conducted to show this difference is statistically observable (K. Fresh, WDFW, pers. comm. 2001). Even under the most optimistic estimate, less than 5% of habitat in the river consists of pools. Sufficient cool water pool habitat is critical for adult migration and thermoregulation.

To adequately provide refuge and holding habitat in the river, pools should be of depth and area sufficient to provide low-velocity resting habitat for one or many adult salmon in each pool. More than 30% of the pool bottom should be obscured due to surface turbulence, turbidity, or presence of logs, boulders, or overhanging vegetation (Raleigh *et al* 1986). Although velocity in the Sammamish River is typically not high enough to deplete an adult salmon's energy reserves, the high water temperatures result in a greater need for rest and thermoregulation. To provide adequate habitat for adult migration and juvenile rearing, the Sammamish River should have pools with greater than 1.5 ft (0.4 m) residual depth (based on TFW criteria, will vary from 5 to 12 ft [1.5 - 3.6 m] total depth at low flows depending on where located in the river) and in total comprise an area between 40% to 60% of the total surface area of the river (Raleigh, *et al*. 1986). NMFS criteria (NMFS 1996) in their Matrix of Pathways and Indicators for holding pools are greater than 3.3 feet (1 meter) in depth with good cover and cool water.

In many of the reaches characterized by Jeanes and Hilgert (1999), the dominant substrate was silt and clay. Typically, reaches were dominated by 70 to 90% silt and clay, but were mixed with 10 to 30% sand, large gravel, or all sizes of cobble. Only one 150-foot (45 m) reach was dominated by gravel, and only 9% of reaches contained any gravel substrate at all. Under existing conditions, only a couple of small areas in the river are suitable for salmon spawning (less than 15,000 ft^2 [1400 m^2] total area; under ½% of the river substrate area*).* Salmon species prefer to spawn in relatively silt-free, gravel-rubble areas, with substrate

[4] According to the TFW criteria, for a river with a bankful width greater than 20 m, a pool must have a minimum surface area of 5 m^2 and a minimum residual pool depth of 0.4 meters to be considered a pool. Only two pools were identified that met these criteria.

[5] 1998 is considered the warmest year on record world-wide by the Intergovernmental Panel on Climate Change (2001) since recording began in 1861. King County data also supports that 1998 was a warmer than average year (D. Houck, pers. comm.).

sizes between 0.3 and 15 cm (Raleigh, *et al*. 1986; Bjornn & Reiser 1991). While conducting the habitat assessment of the mainstem Sammamish River, Jeanes and Hilgert (1999) observed kokanee spawning in three small riffles (Little Bear Creek mouth, Tributary 101 mouth and Leary Way bridge) that do have suitable gravel. In 2000, some coho were also observed spawning in the transition zone just downstream of the weir (E. Jeanes, R2, pers. comm. 2001) Salmon may spawn in glides if they are of suitable velocity and contain appropriate substrate, although it has not been observed in the Sammamish River. Overall, while spawning habitat should not be a priority for restoration because it is not likely to persist in the low velocity river, existing areas of spawning should be protected *(i.e*. at tributary mouths).

Substrate plays a significant role in foodweb production and food availability in the stream. Areas dominated by silt and clay substrate do not support a wide variety of readily accessible, preferred juvenile salmon prey items, primarily larval and adult insects (Healey 1991; Sandercock 1991). Preferred aquatic prey organisms (*e.g.*, chironomids, ephemeropterans, crustaceans; from Higgs *et al* 1995) for salmon species typically occur in gravel and cobble substrates or from overhanging vegetation.

Shallow sloping banks and shallow water are often preferred rearing areas for fry and small juvenile salmon (Peters 1999). R2 Resource Consultant staff recently observed that the areas in the river primarily utilized by sockeye and coho fry were shallow bank areas where banks or levees had been set back (E. Jeanes, R2, pers. comm. 2001). Overhanging vegetation also plays a significant role in providing prey items for salmon species. Many juvenile salmon use terrestrial insects as a major food source. In general, very minimal overhanging vegetation exists along the river (except blackberries). Blackberries do provide some insect input, although species diversity and abundance is not known.

A total of 92 pieces of LWD were observed in the Sammamish River, however; only ten are considered “large logs” as defined in TFW (NWIFC 1994) as having a diameter greater than 20 inches (50 cm) (Jeanes and Hilgert 1999), and only seven pieces would meet NMFS LWD criteria (1996) as being greater than 24 inches (60 cm) in diameter. In general, the size requirement is based on the fact that in most large rivers only "large" logs can typically be sustained because of their size and mass. Most of these larger pieces are associated with recent restoration efforts. Only one of the 92 pieces identified was providing a pool forming function (in the transition zone). Overall, there is a significant lack of wood, and wood-created habitat, in the Sammamish River. The average number of LWD per mile averaged less than 7; NMFS criterion (1996) is for greater than 80 pieces of LDW per mile that meets the 24-inch criterion. As previously discussed, the river has been subject to LWD removal for the past 100 years to both aid navigation and aesthetics. LWD provides many essential functions for habitat formation including scour and trapping of sediment; formation of side channels, riffles and pools necessary for cover and resting areas for fish; trapping of detritus and nutrients; and decomposition and food web support (Maser & Trappe 1984).

A study recently completed by R2 Resource Consultants (Jeanes & Hilgert 2001) evaluated juvenile salmon use of various habitats in the Sammamish River. Jeanes & Hilgert (2001) found that the limited available LWD cover and scour habitat did not seem to be used significantly by juvenile salmon and instead found most juvenile salmon were observed in shallow water areas (shallow sloping banks), where the river bank had been set back. Some juvenile salmon were also observed in shallow bank habitats with LWD, and at sites with steeper banks and LWD; however, their numbers were lower than sites with shallow water and no wood. It is possible that the cover and low-velocity habitat typically provided by LWD in other northwest river systems is not a significant habitat element in such a low-gradient, low-velocity river as the Sammamish, and it functions more like LWD in lakes. Adult salmon have primarily used pools and other deeper areas for holding during upstream migration. Although there is some evidence that they utilized overhanging vegetation and other cover to a lesser extent (R. Tabor & D. Houck, pers. comm. 2001).

WATER QUALITY

In general, water quality in the Sammamish River is poor. Although the Sammamish River is officially classified as a Class AA stream (WAC 173-201), for some parameters, it does not even meet Class C water

quality standards set by the state of Washington. Water temperatures as high as 80°F (27°C) have been measured in late July in the Sammamish River (Martz, *et al* 1999). This is well above the lethal limit for salmon, and well above the Class AA standards (currently at 60°F [15.5°C][6], which is considered the upper end of optimal or natural temperature for salmon species). Three areas of the mainstem river are 303(d) listed for temperature (See Table 2 below) (WDOE 1998). The NMFS temperature guideline (NMFS 1996) for properly functioning conditions for salmon is 50-57°F (10-14°C). Additional 303 (d) listings are in effect for pH, dissolved oxygen, and fecal coliform. Each of the listings falls within one of three areas, including Kenmore, Bothell, and Redmond. The lower reaches of Swamp, North and Bear Creek are also 303(d) listed for fecal coliform. King County is currently in the process of conducting an assessment of sediment and water quality in the Sammamish River to determine the presence and distribution of chemical contaminants (i.e., pesticides, metals and organic compounds). The study included collection of water and sediment samples for analysis of chemistry (sediment and water), toxicity (water) and benthic community structure (sediment). Analysis of these data is not yet complete, however, preliminary water quality results indicate bacteria are present at concentrations exceeding state water quality standards (confirms 303(d) listings previously discussed), aluminum concentrations exceed the EPA chronic water quality criteria in some locations. Concentrations of organic compounds and nutrients in water samples were not present at elevated levels. Toxicity was observed in four water samples, although the specific cause is unknown. Sediment samples contained slightly elevated levels of arsenic, chromium and nickel; however, these levels may be associated with background soil concentrations. Sediment PAHs were also slightly elevated in some locations. The data analysis is currently being conducted, but it appears that the known pollutants such as bacteria are still a concern. More evaluation on the potential cause of the observed toxicity is warranted. Because these samples were taken during base flow conditions, there were not elevated turbidity levels. High turbidity levels have been anecdotally observed during winter storm flows, but no single source has been identified. Elevated turbidity may be a result of several sources including stormwater runoff from streets and urban areas, runoff from agricultural fields or parks, resuspension of the fine silty sediments in the river and other sources. In general, based on the current 303(d) listings, water quality conditions are clearly impaired in the corridor.

Table 2. Locations of 303(d) listings within the mainstem Sammamish River

Location	303(d) Listings
Within Kenmore just upstream of outlet into Lake Washington	Temperature and Fecal Coliform
Within Bothell between 100th Ave N.E. and I-405	Temperature, Fecal Coliform, and Dissolved Oxygen
Within Redmond between Lake Sammamish and Hwy 908	Temperature, Fecal Coliform, and pH

Daily high temperatures in the upper Sammamish River frequently exceed 68°F (20°C) and on some occasions have exceeded 80°F (26.6°C) (Corps unpublished temperature data from 1998 and 1999, see Figure 3 for summer temperatures at several points in the river). Temperatures between Lake Sammamish and above the mouth of Big Bear Creek are typically the highest in the river because the tributaries provide

[6] Ecology is in the process of revising their temperature standards; proposed revisions are available at http://www.ecy.wa.gov/programs/wq/swqs/index.html.

some cooling of the mainstem, thus moderating temperature further downstream. The surface water outflow from Lake Sammamish is the warmest water in the system.

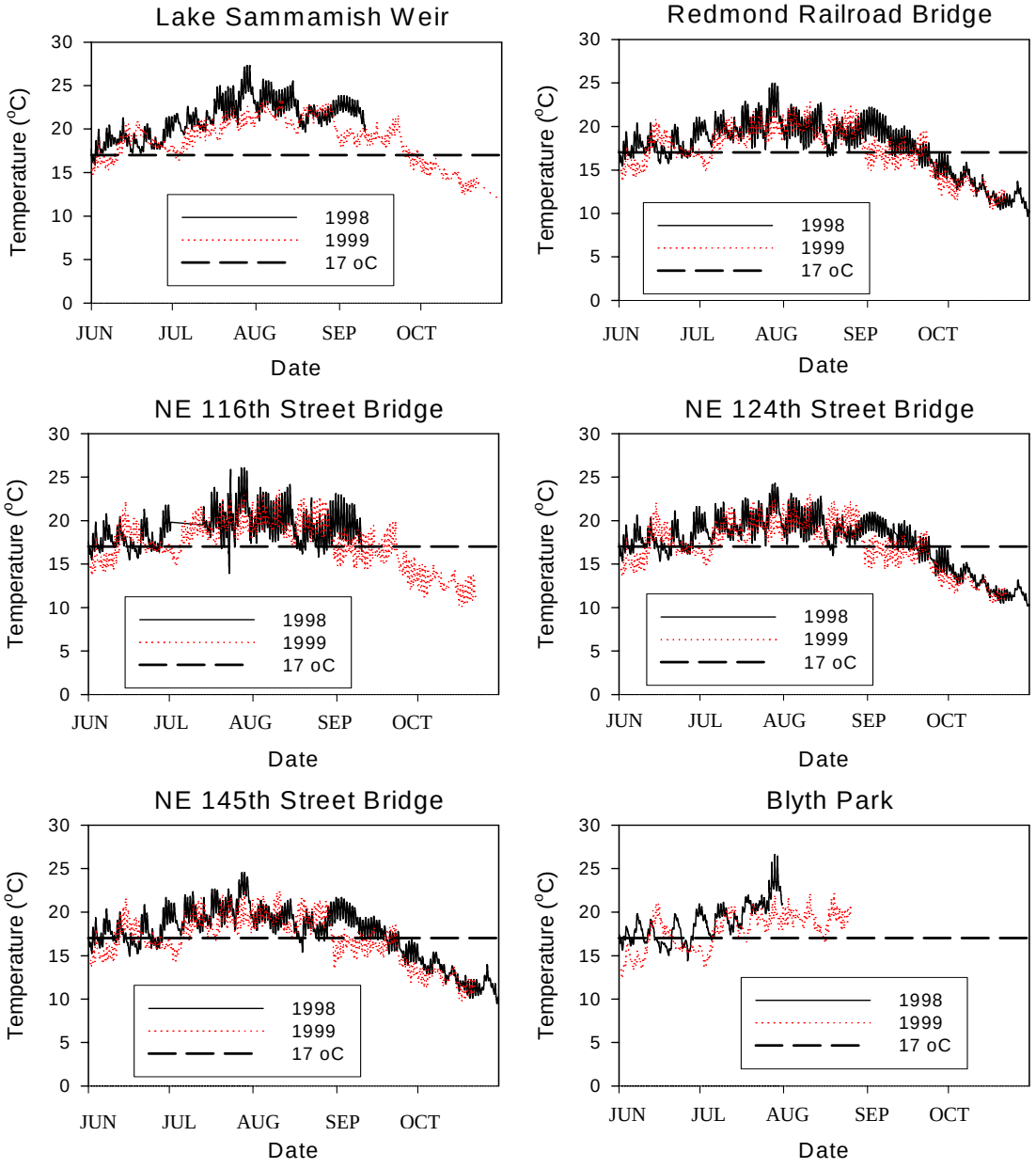


Figure 3. Temperature data from USACE compared to the 17°C fish stress temperature used in temperature modeling. See Appendix B.

Elevated temperature is likely the most significant limiting factor to salmon species in the Sammamish River because it is well within the range of causing adverse physiological and behavioral effects, and frequently in the lethal range. High temperatures in the Sammamish River can affect the reproductive health and survival of all adult salmon entering the Sammamish Watershed and potentially affect smoltification, smolt migration, and habitat suitability for juvenile rearing. Adult chinook and sockeye salmon are the primary species and age group likely to be adversely affected by elevated water temperatures (Martz, *et al*. 1999). This is because adults of these species enter the basin in August and September when temperature is typically highest. This migration pattern coincides with temperatures that have both lethal and sub-lethal effects, including death, disorientation, egg retention, production of abnormal embryos or alevins, high fry or alevin mortality, increased vulnerability to disease of adults and offspring, and other physiological problems (Berman & Quinn 1991 and 1989). Temperatures above 70°F (21°C) equal or exceed lethal temperatures for chinook (McCullough 1999). Sockeye may be able to tolerate slightly higher temperatures than chinook, but geometric mean survival times for adult sockeye is only 1,000 minutes at 75°F (24°C) and 100 minutes at 79°F (26°C) (Servizi and Jensen 1977, cited in McCullough 1999). Berman (1991) experimentally held Columbia River spring chinook at 66°F (19°C) for 1.5 months, and all perished of columnaris infections, while fish held at lower temperatures (the "control" fish in the study) experienced no mortality. High temperature can also cause a migration barrier, where fish refuse to move upstream into the higher temperatures (as appeared to occur at the locks in 1998; Fresh, *et al* 1999), and delays as few as 3-4 days have possibly caused pre-spawning mortality (Andrew and Geen 1960 cited in McCullough 1999). This delay also increases susceptibility to disease and reduces egg viability when spawning grounds are finally reached (McCullough 1999; Berman 1991). See Table 3 for a list of salmonid species and their temperature requirements.

Fecundity and survival data for chinook returning to the Issaquah Hatchery from 1995 to 1998 show no trends (Martz, *et al* 1999). There is high variability between fish, generally within the normal range. No information on egg viability or deformities was available.

Juvenile salmon may also experience high temperatures in the Sammamish River during June and July (Corps unpublished temp data from 1998-1999 and Jeanes & Hilgert 2001; see Figure 4 for timing of juvenile salmon use of the river). Juvenile salmon mortality can result from exposure to elevated temperature, inadequate feeding (higher metabolism, reduced feeding), and increased disease incidence. Smoltification is also affected by temperature and can either occur too early when temperatures are higher (and juveniles are smaller) or be incomplete leading to reduced survival when fish reach saltwater (McCullough, 1999) or even cause desmoltification.

Tracking of adult chinook in 1998 and 1999 indicates that during migration adult salmon utilize every available deeper spot in the Sammamish River, likely in an attempt to find cooler water temperatures and/or cover. One mechanism that salmon use to cope with elevated temperature is to reduce activity and hold in cooler pools (Berman & Quinn, 1991). Also, many fish were observed to migrate primarily at night, likely because river temperature drops each night as ambient air temperature cools (although predator avoidance could also be a factor). In the warmest reach of the river, upstream of Bear Creek, the adult chinook migrated only at night (Fresh, *et al*, 1999). Spawning data is not conclusive, but fish returning to the Issaquah Hatchery or Issaquah Creek may spawn in Bear Creek or other tributaries when temperatures upstream of Bear Creek are too high.

Table 3. Salmonid species and temperature requirements			
Information from (Bell 1991; Kraemer 1994; USFWS 1998; McCullough 1999)			
Species	**Lethal Limit**	**Upper Optimal Limit**	**Present in River July through October?**
Chinook	77°F (25°C)	58°F (14°C)	Adults – yes Juveniles - yes
Coho	78°F (25.5°C)	69°F (20.5°C)	Adults – yes Juveniles - unknown
Sockeye	76°F (24.4°C)	58°F (14°C)	Adults – yes Juveniles – no
Steelhead	75°F (23.9°C)	58°F (14°C)	Adults – no Juveniles – unknown
Cutthroat	73°F (22.8°C)	55°F (12.8°C)	Adults – yes Juveniles – yes
Bull trout		58°F (14°C)	Unknown

WATER QUANTITY

As previously discussed, construction of the Lake Washington Ship Canal and locks dropped the surface elevation of Lakes Washington and Sammamish by 9 and 6 feet, respectively. Water levels in the Sammamish River also decreased, lowering the base flow as a result of reduced floodplain and groundwater connections. The flood control channelization project further disconnected and drained the floodplain, likely causing additional loss of groundwater flow into the river as a result of reduced floodplain storage. It is estimated that summer base flow in the Sammamish River upstream of Little Bear Creek has been reduced by approximately 16 cfs (WRIA-8 Technical Subcommittee 2001), primarily from water management and withdrawals. This is an estimated 29% reduction in historic base flows upstream of Little Bear Creek, with approximately a 21% reduction downstream of Little Bear Creek (lesser reduction in the lower river is primarily due to the importation of water (municipal water supply) from the Cedar River and other basins; [WRIA-8 Technical Subcommittee 2001]). Impervious surface area has increased in the Sammamish floodplain as well, further contributing to a decline in groundwater recharge and reduced low flow conditions. Water withdrawals for domestic and agricultural uses may have reduced water volume in the river resulting in greater heating of the smaller volume of water (Jain, *et al* 2000). It is unknown however, if groundwater withdrawal for domestic and agricultural use directly translates into reduced groundwater inflow to the river. King County is currently investigating the potential volume and quality of groundwater flow into the river. This information will be useful in determining potential options to increase groundwater flow.

DESCRIPTION OF FISH POPULATIONS

Six species of salmon are known to currently be present in the overall Sammamish River watershed[7]: (i.e., chinook, coho, and sockeye salmon, kokanee, and steelhead and cutthroat trout). The presence of bull trout has not been confirmed, but will still be discussed in this section. Chum salmon occasionally stray into the watershed, but are not known to be a sustaining population. All information provided below is summarized from Kerwin (2001) and Washington Department of Fish and Wildlife (WDF, *et al* 1992 and www.wa.gov/wdfw/ which provides summaries of stock conditions*)* unless otherwise noted. This section is not intended to be a definitive description of the various populations, but a summary from the most recent compilations of existing data. Stocks of the various species are described as defined by WDFW and the Muckleshoot Indian Tribe, and Evolutionarily Significant Units (ESUs) are described as defined by the National Marine Fisheries Service (NMFS). Stock and ESU designations are not necessarily the same for each species or between species. A stock is considered a discrete breeding population which can occupy a specific lake or stream or a combination of lakes and/or streams but do not interbreed with another stock spawning in a different place, or in the same place at a different season (WDF 1993). An ESU is defined as a distinct population of fish that does not interbreed with other populations, hence a species (NMFS 1997). There may be several stocks of one species within a given watershed (i.e. North Lake Washington tributaries, Cedar River) based on their run timing or lack of interbreeding. An ESU typically encompasses a species from several watersheds that have similar run timing and the potential to stray between watersheds and interbreed (i.e. Puget Sound).

Chinook

Kerwin (2001) has identified two stocks of chinook salmon that are present in the Sammamish River watershed: (1) North Lake Washington tributaries stock, that may be native, although it has likely been influenced by Issaquah Hatchery strays, and (2) Issaquah Creek stock considered non-native (derived from the Issaquah Hatchery; ancestry from several south Puget Sound basins). Both stocks are summer/fall runs and adults enter the Lake Washington basin from June through November. Spawning occurs from September through October and fry typically emerge from redds from January through March. For most ocean-type chinook such as the majority of Lake Washington basin chinook, juveniles may rear in tributary streams, larger rivers, lakes, or estuaries for one to six months before migrating into estuarine areas. Peak smolt outmigration typically occurs at the locks from June through August, but smaller numbers outmigrate from February through September (see Figure 3 for timing in the Sammamish River). There may be a small number of stream-type chinook present in the watershed, which rear for approximately one year in freshwater prior to outmigrating. Natural spawning takes place in Bear and Cottage Lake Creeks and in Issaquah Creek, and smaller numbers of chinook spawn in Little Bear, North, and Swamp Creeks. The North Lake Washington tributaries stock has declined severely in the past several years and is part of the Puget Sound Evolutionarily Significant Unit (ESU) listed as threatened; fish returning to the Issaquah Creek Hatchery are currently not listed with the Puget Sound ESU, but all naturally spawning chinook in Issaquah Creek are part of the ESU. Between 1983 and 1987, escapement to Bear Creek averaged 300 individuals. Between 1992-1997, that number declined to less than 100 for each year; however, more detailed surveys conducted in 1998 and 1999 estimated escapement at 401 and 733 fish, respectively (Carrasco *et al* 2001 and Mavros *et al* 2001). Jeanes and Hilgert (1999) observed a few chinook in a riffle of the Sammamish River near Lake Sammamish during their habitat surveys. However, chinook are generally not expected to spawn in the Sammamish River.

[7] Includes the Sammamish River and all its tributaries, including tributaries to Lake Sammamish.

Coho

The coho salmon that occur in Lake Washington and the Sammamish tributaries are considered as a single stock, which is a mixed stock of native and hatchery derived fish. A significant proportion of this stock returns to Issaquah Hatchery. This stock is listed as depressed by WDFW (WDF, *et al* 1992), and is part of the Puget Sound/Strait of Georgia ESU, which is a candidate for listing under the ESA. Adult coho enter the locks from August to December. Spawning typically occurs in tributaries in November and December, although some spawning occurs as early as October. Fry emerge from redds from March through June and juveniles typically rear in freshwater for one year. Juveniles utilize the tributaries, mainstem river (limited use, Jeanes and Hilgert 2001), and Lakes Sammamish, Washington and Union for rearing. In general, freshwater habitat that is more structurally complex with dense LWD, pools, and other cover typically supports the most coho juveniles (Sandercock 1991). Smolts typically outmigrate through the locks in May as yearlings (see Figure 3 for timing in Sammamish River). Escapement since 1989 has been very low (less than 5,000). Coho are not known to spawn in the Sammamish River and surveys are not conducted along the mainstem (although some spawning activity was observed by E. Jeanes in 2000, downstream of the weir [E. Jeanes, R2, pers. comm. 2001]), however, coho are known to spawn in Issaquah, Bear, and Little Bear Creeks.

Sockeye

One stock of sockeye salmon occurs in both Lake Washington and Sammamish River tributaries. This stock is of unknown or mixed origin. A significant number of sockeye fry hatchery releases occurred throughout the greater Lake Washington watershed up until at least 1954, although there are also reports of sockeye and/or kokanee present in the system dating back to the turn of the century. Adults typically enter the Lake Washington basin from June through November. Spawning typically occurs in Bear, Cottage Lake, and Issaquah Creeks and in smaller numbers in Little Bear, Swamp, and North Creeks, and several Lake Washington tributaries, from September through December or January. Sockeye are not known to spawn in the Sammamish River. In the tributaries, fry emerge from redds from February through May and migrate down to Lake Washington or Lake Sammamish to rear for approximately one year. A smaller number of sockeye fry rear for one to two months in tributaries on their way down to the lakes (fry capture data from mouth of Bear Creek and lower Cedar River, D. Seiler, WDFW, pers. comm. 1999). Smolts migrate out through the locks in May and June (see Figure 3 for timing in the Sammamish River). This stock is listed as depressed by the SaSSI (WDF 1992), but is not listed under ESA. Escapement for this stock was lowest in 1989, 1995 and 1999 when fewer than 5,000 individuals were recorded in the Sammamish tributaries and highest in 1996 with greater than 70,000 individuals (primarily in Bear and Cottage Lake Creeks).

Kokanee

Kokanee salmon are a freshwater form (non-anadromous) of sockeye salmon. They rear in lakes and spawn in tributary streams. At least two stocks of kokanee have been identified in the greater Lake Washington Basin: (1) early run Issaquah Creek; and (2) a late run population found in the East Lake Sammamish tributaries of Ebright, Laughing Jacobs, and Lewis Creeks (Kerwin 2001). Though many kokanee of Lake Whatcom origin were outplanted throughout the Lake Washington basin over the years, genetic sampling suggests that those fish have not survived (S. Brewer, King County, pers. comm. 2002). Genetic sampling of the Issaquah Creek, East Lake Sammamish tributaries and Bear and Cottage Lake Creeks has occurred and the two above stocks have been identified as distinct populations (S. Brewer, King County, pers. comm. 2002). Kokanee from Bear and Cottage Lake Creeks are not distinguishable from the sockeye populations in these creeks. None of the fish sampled are similar to the Lake Whatcom stock. Kokanee have been observed spawning within the Sammamish River in at least three locations[8] in early October 1999 (Jeanes and Hilgert

[8] Kokanee were observed spawning at the Little Bear Creek outlet, Tributary 101 outlet and at the Leary Way bridge in Redmond in small numbers (range 5 to 20 redds).

1999). Several kokanee were observed attempting to ascend over a large cottonwood log in lower Bear Creek in early September 1998 (Martz, M. observation of 6-10 kokanee 1998). Kokanee from the Sammamish River have not been genetically evaluated and their origin and distinctness as kokanee is yet to be determined.

Early run adults in Issaquah Creek spawn in August and September. Fish found in tributaries to the Sammamish River were noted to spawn during the fall months of September, October, and November, whereas the late run to Lake Sammamish tributaries spawns from late October through December or January. The early run to Issaquah Creek is considered native (Ostergaard, *et al* 1995). The kokanee found in the Sammamish River tributaries may also be native, but more sampling needs to occur to determine if they are residualized sockeye. It is not known whether juvenile kokanee utilize the Sammamish River.

Kokanee stocks have declined dramatically in the past 20 years. The early run Issaquah Creek kokanee have been petitioned for listing as endangered and are designated in critical condition (WDF, *et al* 1992). Further surveys and genetic sampling throughout the greater Lake Washington basin, including the Sammamish River, will be necessary to determine the presence and status of kokanee.

Steelhead Trout

Steelhead trout throughout the greater Lake Washington basin are considered one stock. This stock is considered native and is listed as depressed by WDFW (WDF, *et al* 1992). This stock has declined to fewer than 1000 adults since 1986, likely a result of a number of factors including sea lion predation at the locks and loss of spawning and rearing habitat. A small broodstock supplementation program was initiated in 1994, however escapement has not significantly improved and no broodstock have been collected in the last few years. Adults typically enter the locks from December through March and spawn in all accessible tributaries from March to June (no spawning is known to occur in the Sammamish River). Juveniles rear in freshwater from one to three years and then outmigrate as smolts from May through July. Most of the returning fish typically return to the Cedar River; very few, if any, have returned to Sammamish River tributaries in recent years. Fewer than 10 individuals were observed in the Sammamish tributaries in 2000, the lowest escapement year ever (S. Foley, WDFW, pers. comm. 2001).

Cutthroat Trout

Cutthroat trout have a diversity of life history strategies from anadromous (sea-run) to adfluvial to resident. Very little information on cutthroat trout exists for the Lake Washington basin, particularly the anadromous form. A sizable adfluvial population is known to exist in Lake Washington with resident fish also observed in most tributaries, including the Sammamish River. Stock status for coastal cutthroat trout is unknown due to lack of information. The Puget Sound ESU of cutthroat trout are not currently listed under ESA, and are considered "not warranted" for listing by NMFS and the USFWS (http://www.nwr.noaa.gov/1salmon/salmesa/cuttpug.htm). Adfluvial and resident adults spawn in tributaries and rivers in April and May, and anadromous fish spawn in December/January, previously coinciding with the steelhead migration and spawning (S. Foley, WDFW, pers. comm. 2001). Juveniles may spend several years in freshwater before outmigrating. Escapement values are unknown at this time.

Bull Trout

Western Washington bull trout are listed as a threatened species under ESA (USFWS 1999). The USFWS considers all bull trout that occur in coastal Washington and Puget Sound drainages as a distinct population segment (DPS). The stock status for bull trout in the Lake Washington Basin is largely unknown, and information on their abundance is extremely limited. Studies are currently underway by King County and other agencies to determine if any bull trout remain in the Lake Washington basin. It is known that a self-sustaining, adfluvial population occurs above Chester Morse dam in the upper Cedar River (WDFW 1998). A few stray individuals have been observed in scattered locations in the Lake Washington watershed

(WDFW 1998 cites B. Fuerstenberg observation in Issaquah Creek in 1993, M. Martz person observation in 1998 in the Cedar River), but no pairs or redds have been observed. Bull trout prefer very cold headwater streams (temperatures generally less than 55° F [13° C]) and utilize boulder step pool habitat. Spawning typically occurs in late summer and fall (late August through November) in areas of cobble and gravel substrate with overhead cover. Wall-base side channels are often suitable for spawning as well. Fry emerge in April and May and rear in amongst LWD, cobbles, and boulders. Juveniles and adults also utilize pool habitat extensively (summarized from Kraemer 1994). It is possible the headwaters of Issaquah and Bear Creeks could provide suitable habitat for bull trout. However, due to the elevated water temperatures in the Sammamish River it would be unlikely that bull trout are present in the corridor.

Other Fish Species

Many other fish species are known to be present in the Sammamish River and its tributaries including native species such as longfin smelt, northern pike minnow, peamouth chub, three-spine stickleback, largescale sucker, longnose dace, brook lamprey, and several species of sculpin, and non-native species such as yellow perch, smallmouth bass, largemouth bass, brown bullhead, warmouth, pumpkinseed sunfish, tench, and carp (Wydoski & Whitney 1979; E. Warner, MIT, pers. comm.1999). Predation by non-native fish species on salmon fry and juveniles may be a significant issue in the Sammamish River, although limited sampling has occurred to verify this theory. The river currently provides excellent habitat for warm water species as a result of the elevated temperatures (water temperatures around 80°F are optimal for largemouth bass; Wydoski and Whitney 1979). There is also likely some longfin smelt spawning habitat in the lower reaches of the river near Kenmore.

WILDLIFE

Many bird, mammal, reptile, and amphibian species are present in the Sammamish River Corridor, although many species that historically utilized the old growth forest and extensive wetlands no longer occur in the watershed. Mammals present today include those species that have adapted to human development such as deer, beaver, mountain beaver, nutria, raccoon, opossum, skunk, river otter, coyote, rabbits, shrews, mice, and voles. Bears are occasionally observed in the upper end of the Bear Creek sub-basin (R. Heller, pers. comm. 1996). State and federally listed mammals or species of concern that may occur in the watershed include western pocket gopher and gray-tailed vole. Species of local importance in King County include marten, mink, Columbian black-tailed deer, elk and mountain goat. These species are most likely to be present east of the Sammamish River Corridor in the Cascade Mountains (King County 2002).

Although many bird species utilize the river and lakes, riparian area, and particularly the wetland areas of Marymoor Park, the available habitat is fairly degraded and could be much improved, particularly the riparian areas. Species that utilize the corridor include those listed in Table 4.

Several bird species are listed on the federal or state endangered species lists and King County has designated several species as species of local importance. Listed species or species of local importance that may occur in the corridor include red-tailed hawk, osprey, great blue heron, band-tailed pigeon, harlequin duck, northern goshawk, merlin, peregrine falcon, Vaux's swift, pileated woodpecker, olive-sided flycatcher and purple martin (King County 2002). With the exception of Marymoor Park, the riparian forested and shrub habitats that many migratory bird species use are significantly lacking in the Sammamish River Corridor. Following shoreline revegetation in Marymoor Park in 1998 as part of the Corps weir replacement project, Swainson's thrush was observed using the newly created shrub habitat (Tweeters 1999).

Western pond turtles, a state endangered and federal species of concern, may be present in the Sammamish River Corridor, although none have been recently observed in the watershed, they are believed to have been present historically. Western pond turtles would likely benefit from restoration efforts if combined with a reintroduction effort. Their habitat and survival is reduced due to lack of basking logs or boulders, human disturbance, and lack of suitable nesting and wintering sites. Pond turtles typically prefer un-vegetated,

south-facing clay slopes to dig nests in and require forested uplands with a dense layer of leaves and other organic material for wintering habitat (Holland 1994). Western toad is a state and federal species of concern that may occur in the Sammamish Corridor. They prefer forested or meadow habitats with brush or LWD for cover. Red-legged frogs are another species of concern that may have been eliminated from the Sammamish River Corridor. Bullfrogs and predatory fish such as bass that occur in the Sammamish River often prey on red-legged frogs, further reducing survival or frequently causing local extinctions (probably extinct along the Sammamish River). Red-legged frogs require seasonally inundated wetlands for egg laying and prefer a dense riparian zone for cover and foraging (Corkran and Thoms 1996). Northern leopard frogs and Oregon spotted frogs are both state endangered and federal species of concern that are believed to have been extirpated from the Puget lowlands due to the presence of bass and bullfrogs and loss of habitat. They prefer slow moving streams and seasonal ponds and wetlands, which would have historically been present in the Sammamish River Corridor.

Table 4. Bird species that currently are present in the Sammamish River Corridor.

*(All bird information from the King County wildlife program data and Friends of Marymoor Park list at **www.scn.org/fomp/birdlist.htm**)*

pied-billed grebe	Western grebe	double-crested cormorant
great blue heron	green heron	Canada geese
wood duck	gadwall	mallard
northern shoveler	green-winged teal	canvasback
ring-necked duck	greater scaup	lesser scaup
bufflehead	common goldeneye	hooded merganser
common merganser	osprey	bald eagle
sharp-shinned hawk	Cooper's hawk	red-tailed hawk
Virginia rail	American coot	killdeer
spotted sandpiper	mew gull	ring-billed gull
California gull	glaucous-winged gull	rock dove
band-tailed pigeon	Vaux's swift	rufous hummingbird
belted kingfisher	downy woodpecker	northern flicker
western wood-pewee	willow flycatcher	warbling vireo
red-eyed vireo	Steller's jay	American crow
tree swallow	violet-green swallow	cliff swallow
barn swallow	black-capped chickadee	bushtit
Bewick's wren	winter wren	marsh wren
golden-crowned kinglet	ruby-crowned kinglet	Swainson's thrush
American robin	European starling	cedar waxwing
yellow warbler	yellow-rumped warbler	common yellowthroat
spotted towhee	savannah sparrow	fox sparrow
song sparrow	white-crowned sparrow	dark-eyed junco
black-headed grosbeak	red-winged blackbird	house finch
pine siskin	American goldfinch	house sparrow

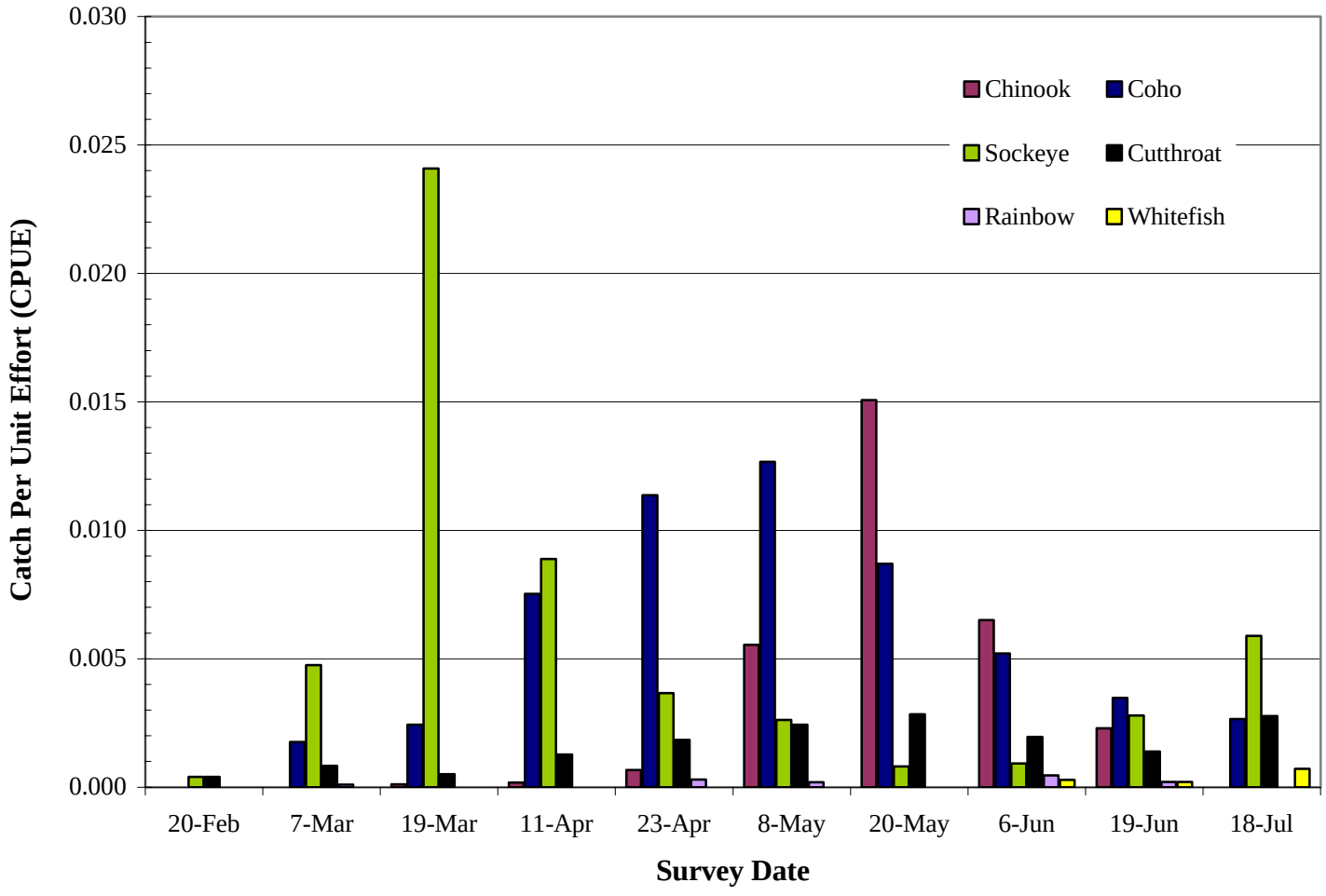


Figure 4. Catch per unit effort indices by species for survey sites located in the Sammamish River, Washington, 2001.

(from Jeanes and Hilgert, 2001)

TRIBUTARY CONDITIONS

Tributaries entering the Sammamish River also affect the river's ability to provide fish and wildlife habitat. A number of recent habitat surveys have been conducted in the watershed including surveys of the major tributaries (Fevold *et al* 2001), Bear Creek (King County, not published), and the minor tributaries (Jeanes and Hilgert 1999; and Jones and Stokes for the Corps of Engineers, not published). Fevold *et al* (2001) reported that, in general, ecological conditions in Little Bear, North and Swamp Creeks were slightly better than the mainstem, but are still relatively degraded. Kerwin (2001) notes a number of issues in the major tributaries including fish passage barriers in Bear, Little Bear, and North Creeks; degraded riparian conditions in Little Bear and North Creeks; altered hydrology or flows in Bear, Little Bear, North, and Swamp Creeks; 303(d) listings for Bear, Little Bear, North, and Swamp Creeks and degraded channel complexity and altered sediment transport processes in Bear, Little Bear, and North Creeks. Typically, all of these tributaries are lacking sufficient LWD and have reduced recruitment capability due to lack of conifers in the riparian area. Residential and commercial development have reduced riparian buffer widths and resulted in significant bank armoring along most of the tributaries to the Sammamish River. Runoff associated with urban, agricultural, and forestry activities has elevated fine sediment loads in the tributaries.

The tributaries provide fair to good quality spawning and rearing habitat for salmonid species. Bear and Cottage Lake Creeks are considered Regionally Significant Resource Areas (King County 1990) because of their support of several salmonid populations[9]. The Bear Creek system also supports other aquatic resources such as freshwater mussels and freshwater sponges (Kerwin 2001). Bear and Cottage Lake Creeks are primarily groundwater fed and provide a significant cooling effect on the Sammamish River (typical summer temps in lower Bear Creek are about 10°F (5.5°C) cooler than the mainstem river and can lower temperatures in the river by as much as 2-3°C; Corps data from 1998 and 1999; [McIntosh and Faux 2001]). Little Bear, North, and Swamp Creeks also provide inputs of cooler water to the river, although not as significant as that provided by Bear Creek. The tributary mouths may be important holding areas for adult salmon and rearing areas for juvenile salmon. The tributary mouths also provide some spawning habitat for kokanee and other species (E. Jeanes, R2, pers. comm. 2001) because they are the only areas of gravel in the mainstem.

Jeanes and Hilgert (1999) conducted a habitat survey of the lower 1,650 feet (500 m) of four unnamed tributaries (WRIA 0090, 0095, 0101, and 0104) that converge with the mainstem river upstream of Woodinville. Habitat quality and quantity in these small tributaries was frequently as poor as that observed on the mainstem; habitat was uniform with minimal cover. No pool habitat was present in any of the tributaries; all areas were dominated by shallow riffle habitat. During the survey (October 1999), these tributaries had flow well below 1 cfs and no water was flowing in Tributary 0090 because it was temporarily diverted around a construction site. Willow and alder were the dominant species in some areas along Tributaries 0090, 0101, and 0104, although reed canary grass dominated other areas. Tributary 0095 was dominated by reed canary grass or sod (from adjacent turf farm) as riparian vegetation. Fish passage to Tributaries 0090, 0095, and 0101 appears limited to high-flow events because of perched culverts at the confluence with the Sammamish River.

Overall, some minor tributaries contribute cooler water, and may even lower mainstem temperatures, at least in localized areas (Fresh, *et al*. 1999, McIntosh and Faux 2001), whereas irrigation return or tributaries that function as agricultural ditches may contribute warmer water to the Sammamish River during the summertime. At this time, there are limited data available regarding temperature conditions in the minor tributaries.

[9] Regionally Significant Resource Areas do not have any specific regulatory protection, but do receive recognition by the County and other local governments as resources which should be protected.

RECREATION FEATURES OF THE CORRIDOR

Many aspects of the Sammamish River Corridor make it a desirable place for recreation. The Sammamish River Trail runs along the north and east banks of the river. The Sammamish River Trail is a former railroad line that was developed into a trail in the mid to late 1970s. The trail parallels the river for about 10 miles starting in Kenmore and ending in Marymoor Park in Redmond. The west bank also has recreational capabilities along most of the corridor, although it is currently unpaved and will likely remain unpaved. Many access points along the river include city and King County owned parks which provide many opportunities to access the corridor for trail and river activities.

The trail offers a variety of uses including bicycling, walking, rollerblading and more. Trail users average approximately 1700 a day. The primary users of the trail are bicyclists (approximately 1200 of the 1700 users per day). The remainder is comprised of walkers, joggers, equestrians, and skaters. Sixty-two percent of these users are recreational and thirty-two percent use the trail for commuting (Moritz 2000). Other activities include bird watching, dog walking, picnicking, and par course use.

The river also offers a variety of recreational activities. The waterway is used by watercraft such as canoes, kayaks, motorboats, and jet-skis. A public boat launch is available at Kenmore Park. An active user of the waterway is the Sammamish Rowing Association located at the upper end of the river in Marymoor Park. Game fishing in the river includes trout, panfish and crawfish. There is likely opportunity to fish for largemouth and smallmouth bass, crappie and other non-native species. The Sammamish River is closed to fishing from June 1 through August 31 every year. Trout fishing is catch and release only and statewide rules apply. Salmon and steelhead fishing is not permitted in the river.

Additional recreational assets along the river corridor include access to athletic fields, golf courses, the wineries and brewery in Woodinville and several city and county parks. King County's Marymoor Park is a regional park with a remote-controlled airfield, climbing wall, sports fields, tennis courts, off-leash dog area, and hiking trails. Most public parks along the corridor are wheelchair accessible and provide restroom and garbage facilities.

SAMMAMISH RIVER REACH DESCRIPTIONS.

The following provides a description of habitat conditions for individual reaches of the Sammamish River. The reaches were designated for this Action Plan based on land use and width of the floodplain. A total of six reaches are delineated. Descriptions presented below detail the primary land uses, instream and terrestrial habitats, tributaries, wetlands, and key restoration opportunities within each reach. Wetland information comes from the National Wetland Inventory, King County Wetland Inventory and a functional assessment of several wetlands in the corridor prepared by Shannon & Wilson (2001) for King County; descriptions of adjacent land uses come from aerial photos from 2000 (obtained from the Corps) and zoning maps from the cities; and aquatic habitat information come from Jeanes and Hilgert (1999). Restoration opportunities identified in this chapter are described in greater detail in Chapter 4.

See Figures 9 through 14 for maps of each reach. Existing riparian coverage is shown on the map with the following codes:

- Coniferous forested – dominated by native coniferous trees
- Deciduous forested – dominated by native deciduous trees
- Scrub/shrub – Dominated by a mix of native shrubs
- Non-native – 50-85% dominated by non-native shrubs and herbs
- Non-native extreme – more than 80% dominated by non-native shrubs and herbs

Reach 1 (RM 0 to 2.5)

This reach begins at the Lake Washington boundary and ends at the 96th Avenue bridge and is located within the cities of Kenmore and Bothell. The end of this reach is in the middle of Wayne Golf Course,

therefore, golf course issues are described for both this reach and reach 2. Land use is primarily residential (~70%). In the near future a former industrial site, located on the north bank at the mouth (LakePointe site), is expected to undergo a cleanup of hydrocarbons and other pollutants, and conversion to commercial and residential use. The remainder of the area within this reach is comprised of parks, undeveloped land, and two golf courses. There are limited areas of forested floodplain, and the vegetated riparian area is typically less than 50 feet (15 m) wide with sparse tree presence. The lower 3,000 feet of the reach contains a greater density of trees and a wider riparian area; however, the remainder of the reach is bordered directly by residential, golf course, or former agricultural land (at Swamp Creek, King County property). Cottonwoods and Douglas fir are present near the lake, but the riparian area within this reach is primarily dominated by blackberry and reed canary grass. Some red alder and willow are also present. The aquatic habitat is 100% glide, with no pools or riffles. Two deeper areas used by adult salmon for holding are present in this reach, at approximately RM 0.8 and 2.3 (D. Houck, King County, pers. comm. 2001). These deeper sites were not identified as pools by Jeanes and Hilgert (1999) because they do not meet the Timber-Fish-Wildlife (NWIFC 1994) criteria for residual pool depths[10]; however, they are slightly deeper than the average channel depth in this reach (R. Tabor, USFWS, pers. comm. 2001). Swamp Creek enters at RM 0.87 and contributes flow that is slightly cooler than the mainstem in both the summer and winter (McIntosh and Faux 1999; USACE unpublished gage data, 1998 and 1999), and adult salmon have been observed holding in a deeper area a short distance downstream of the mouth. Two small tributaries (0057C and 0057D) enter this reach on the left bank at RMs 0.8 and 1.4, from the residential neighborhoods of Kenmore. It is not known if these are perennial streams. Backwater from Lake Washington is present year-round throughout this reach and typically occurs as a warmer surface layer during the summer and fall months (see DeGaspari 2001 in Appendix B). This causes surface temperature in the river to be elevated relative to reaches 2 and 3 (McIntosh and Faux 1999; temperatures on the order of 20-24°C). The temperature in the backwater area is stratified and fish could migrate in deeper water through this reach, but more information is needed to understand the specific temperature dynamics in this reach.

The area adjacent to the mouth of the Sammamish River contains an approximately 20-acre area of semi-permanently flooded or saturated emergent wetland. Another wetland complex of approximately 70 acres, primarily under King County Parks ownership, exists adjacent to Swamp Creek. This wetland consists of a large area of seasonally saturated scrub-shrub habitat with smaller areas of seasonally flooded emergent and forested wetlands. This area represents a significant restoration opportunity, including the potential to reconnect the wetlands to Swamp Creek for more frequent inundation of the floodplain; remove exotic species, which now dominate the site; and revegetate the wetland and riparian area along both Swamp Creek and the mainstem. Wetlands also exist at Kenmore Park and across the river from Swamp Creek. Another key restoration opportunity would be to revegetate the riparian area along both Wayne and Inglewood golf courses. The City of Bothell has an open-space easement with Wayne golf course, so riparian restoration is likely a feasible option at this location.

The primary limiting factors for salmonids in this reach of the river are lack of channel complexity and cover, loss of wetlands, and limited riparian area. Historically, this reach had significant wetland areas and therefore, would be an appropriate location to initiate restoration of wetland habitat. The wetland areas would have provided an excellent rearing area for salmon fry and juveniles prior to entering the deeper waters of Lake Washington. Temperature, while elevated in this reach, is stratified in the Lake Washington backwater and the existing data does not show whether there is cooler water near the bottom of this reach. The Inglewood Golf Course management has undertaken some restoration actions on their property and is willing to implement more restoration features.

[10] For a channel with a bankfull width greater than 20 meters [66 feet], the minimum residual pool depth is 0.4 meters [1.3 feet] and the minimum surface area is 5 m2 [55 ft2].

Reach 2 (RM 2.5 to 4.5)

This reach extends from the 96th Avenue Bridge in Bothell to the North Creek confluence. Adjacent land uses include the upper portion of Wayne golf course, several parks, downtown Bothell, and residential development. The left bank of the river in this reach is mostly undeveloped. This area includes less impervious surface area within 200 feet (61 m) of the river channel compared to Reaches 1, 3, and 5. This reach of the river is the most constrained in a narrow floodplain. In Blyth Park, the riparian area is generally forested with a mix of conifer and deciduous trees (Douglas fir, maple, cottonwood, alder). This reach has the most natural and mature riparian vegetation of any reach, although there are still many areas dominated by reed canary grass, blackberry, or impervious surface. The riparian width in this reach ranges widely from 0 to over 200 feet (0 to 61 m). The aquatic habitat is 100% glide with no pool or riffle habitat. However, there are six deeper areas (as previously defined) in this reach that could be used by adult fish for holding at approximately RM 2.55, 2.7, 2.8, 3.2, 3.5, and 3.9 (D. Houck, unpublished map; in 1998 tagged adult chinook were observed holding at RMs 2.7, 3.5 and 3.9; Fresh *et al*. 1999). All of these deeper areas are associated with the outside of meander bends and are likely areas of bank scour. Horse Creek enters this reach from the right bank in Bothell, and three unnamed tributaries enter this reach (0066, 0068, and 0069) from the left bank, at about RM 2.6, 2.7, and 4.2. Several pipes or open culverts that carry groundwater flow enter the river off of Norway Hill. Lake Washington backwater does influence this reach, although to a lesser extent than in reach 1.

There are two major wetland areas in this reach: (1) along the left bank from 102nd Avenue to Blythe Park and (2) along the left bank adjacent to Bothell Landing Park. Along the left bank there are two former side channels and associated seasonally flooded or saturated wetlands of approximately 10 to 15 acres. On the right bank just downstream of Bothell Landing Park, there is a small pond and associated wetland with an outflow connection to the river. North Creek is the upstream boundary of this reach and does provide some slightly cooler water to the main channel. North Creek currently flows along the far western edge of its natural floodplain and is further constrained by the I-405 and Highway 522 interchange. Backwater from the river extends up the lower few hundred feet of North Creek; possibly reducing any influence its cooler water may have on the river.

Key restoration opportunities in this reach include riparian enhancement along the Sammamish River Trail and reconnection of former side channels and floodplain areas on the left bank near 102nd Avenue. Another restoration opportunity would be to reconnect the river with the pond/wetland and small outflow on the right bank adjacent to Bothell Landing Park. Also, it is possible the groundwater flow from Norway Hill could potentially be used to provide cool water refuge for fish. Tributary 0066 drains a fairly large sub-basin (several hundred acres), and the lower end of the tributary could be enhanced for rearing habitat and to provide a cool water refuge at the confluence. The confluence of North Creek could also be improved to provide wetlands and a cooler water refuge for fish.

The primary limiting factors for salmonids in this reach include lack of channel complexity, cover, and floodplain connectivity and limited riparian area. Even though it still exceeds state standards (typically 20-22°C, see Figure 6), this reach has the lowest temperatures of any reach., Deep pools do not exist in this reach, but the numerous meanders provide opportunities to create scour pools using LWD and other features. The primary limiting factors for wildlife are a lack of a migratory corridor (highly fragmented) and lack of riparian area.

Reach 3 (RM 4.5 to 7.5)

This reach extends from the North Creek confluence up to the 145th Street Bridge. Adjacent land uses are dominated by the City of Woodinville and the I-405 and Hwy 522 interchange. In the lower half of the reach, land use is primarily urban and residential, opening up to agricultural on the right bank in the upper half of the reach. Because much of the floodplain is developed to within 100 feet (30 m) of the river's edge (particularly on the left bank), this reach includes significant areas of impervious surface adjacent to the

channel, which reduces restoration opportunities in this area. The riparian vegetation is dominated by blackberry and reed canary grass; together these two species make up 50 to 90% of the vegetation cover throughout the reach. Trees are very rare and willows occur in only a few locations. Several tributaries enter the river in this reach, including Little Bear, Woodin (0087), and Gold (0088) Creeks, Tributary 0090, and several ditches. Each of the tributaries contributes cooler water to the mainstem during the summer months (McIntosh and Faux 1999). While Little Bear Creek is cooler than the mainstem in the winter, Gold Creek has warmer winter waters that may be a result of groundwater flow. During low flow conditions, Little Bear Creek also contributes a significant cooling effect downstream for up to 825 feet (250 m) (McIntosh & Faux 1999).

Instream habitat includes a single 150-foot (45 m) riffle downstream of Little Bear Creek, and the remainder of the habitat in this reach is glide. The riffle represents approximately 1% of the entire reach length. Kokanee were observed spawning in this riffle during 1999 surveys (Jeanes and Hilgert 1999). Five deeper areas that do not qualify as pools based on the Timber-Fish-Wildlife (TFW) methodology were identified by Fresh *et al* (1999). These areas may provide adult salmon holding habitat at approximately RM 5.6, 6.0, 6.1, 7.1, and 7.5. Only one of these areas was observed to contain tagged chinook in 1998 (R. Tabor, pers. comm. June 2001). Most of these areas are also associated with bridges or the outside of meander bends. These potential holding areas are widely spaced apart, (typically more than 1/2 mile [2640 feet]), likely as a result of the straight channel that exists in this reach. NMFS pool frequency criterion (NMFS 1996) considers 23-26 pools per mile properly functioning conditions (pools approximately every 200 feet).

This reach has a greatest number of wetlands. Wetlands may be present in the former North Creek floodplain (south of Highway 522) and are present adjacent to Tributaries 0087 and 0088, at the Red Hook brewery, and in the mixed-use industrial/commercial lands adjacent to Highway 202. Total acreage of known wetlands is about 50 acres (20 hectares). Other agricultural lands in this reach could potentially contain wetlands, but have not been identified as such. The identified wetlands are seasonally or temporarily flooded or saturated emergent with some scrub/shrub areas (primarily willow or spirea). Wetlands have been restored recently just upstream of the confluence of North Creek and the Sammamish River. Undeveloped lands primarily only exist adjacent to the I-405/522 interchange, along the Sammamish River Trail, and on the agricultural lands. Some restoration was implemented along Gold Creek a few years ago, but there may be additional restoration opportunities in this area.

Key restoration opportunities in this reach include restoration of floodplain interaction and wetland creation in the I-405/522 interchange area, riparian revegetation along the Sammamish River Trail corridor, and restoration of small tributaries to provide wetland and riparian vegetation and create cool-water refuge for fish.

The most obvious limiting factor for salmon species in this river reach is elevated temperature because this reach is far more complex with more forested riparian area than other reaches. However, limiting factors still include lack of channel complexity, cover, and floodplain connectivity and narrow riparian area. Lack of adult cool water holding habitat in this reach is also a significant limiting factor. Wildlife habitat is also extremely poor and limited by the poor riparian corridor and urban development.

Reach 4 (RM 7.5 to 11)

Reach 4 extends from the 145th Street Bridge to the upstream end of the Willows Run Golf Course. Adjacent land uses are agriculture and playfields with a few houses and other structures. Riparian vegetation is overwhelmingly dominated by blackberry and reed canary grass with essentially no trees within the riparian area. Continued heating occurs in this reach in spite of the cooling effects of Bear Creek inflow upstream in Reach 5 due to the almost complete lack of shading and the north-south orientation of the river. Several minor tributaries may contribute cool water in this reach, however, as temperature in this part of the reach is 1 or 2°C lower than that observed at the Little Bear Creek confluence (McIntosh and Faux 1999). The Sammamish River Trail runs parallel with the channel throughout the reach. A 25- to 50-foot (7.5 to 15

m) strip of grass and shrubs (primarily blackberries) are present on either side of the river for the entire reach. A short 100-foot (30 m) riffle is present at the upstream boundary of this reach, and kokanee have been observed spawning here (Jeanes and Hilgert 1999). Seven deeper areas that do not qualify as pools based on the TFW methodology were identified in this reach at approximately RM 9.0, 9.1, 9.7, 9.8, 9.9, 10.3, and 10.7. This reach has only minimal impervious surface area, so there are opportunities to restore oxbows and old channel areas. Several unnamed tributaries (0091, 0095, 0099, 0100, 0101, 0102, 0104) and ditches enter the river in this reach. During the summer months, tributaries 0095 and 0102 were both found to contribute cooler water to the river (McIntosh and Faux 1999). Other than Lake Sammamish outflow, this reach contributes the most heating to the river. Several wetlands are identified on the NWI website (see references), primarily of seasonally inundated emergent habitat, but are currently farmed.

Key restoration opportunities in this reach include revegetation of the riparian area between the trail and river, or perhaps relocation of the trail away from the river to allow for a larger buffer. Although it will likely not be possible to move more than a few sections of trail further from the river. In this reach the river is also severely lacking in aquatic habitat complexity in the form of LWD, pools, and other cover. Also, this reach is the most channelized and straightened and would benefit from some channel remeandering. Wetlands in this reach could be restored for groundwater recharge or wildlife habitat as feasible with the agricultural and other development constraints.

The primary limiting factors for salmon in this reach are elevated water temperature, lack of channel complexity and floodplain connectivity and essentially no riparian area. This reach has undergone the most radical change from historic conditions. Historically, numerous meanders were present in this reach, and it is now virtually straight.

Reach 5 (RM 11 to 12.5)

This reach extends from the downstream end of the Willows Run Golf Course to the Bear Creek confluence. Adjacent land uses are predominantly urban, commercial, and residential. Only the narrow corridor along the Sammamish River Trail (both banks) and near the Bear Creek confluence is undeveloped. The City of Redmond has undertaken several restoration projects associated with their RiverWalk plan that have included riparian revegetation and instream habitat features; however, the riparian area in this reach is still dominated by grasses until the recently planted trees and shrubs begin to mature. One 50-foot (15 m) pool is located just downstream of the Bear Creek confluence and one 50-foot (15 m) riffle were identified in 1999 (Jeanes and Hilgert 1999). Recent restoration associated with RiverWalk appears to have created some additional riffle and pool habitat associated with placement of gravel and LWD. In addition, six deeper areas were identified for potential adult salmon holding in this reach, most of which are associated with bridge piers and outer meander bend scour. These deeper areas are located at approximately RM 11.3, 11.7, 11.8, 11.9, 12.1, 12.3, and 12.5. Peters Creek and Bear Creek enter this reach of the river, both of which provide cooler water in the summer, particularly Bear Creek, which typically provides the river with a volume of water equal to the volume that flows from Lake Sammamish. This reach, like Reach 3, is highly developed adjacent to the river.

Wetlands present in this reach include a pond and associated wetland on the Willows Run Golf Course (approximately 3 acres [1.2 hectares]) and there is potential that wetlands exist across the river in an area of a former meander. Other currently farmed areas may also contain wetlands, although it is not known at this time.

Key restoration opportunities for this reach include creation of cool water refuge for salmon at the Bear Creek confluence and at Peters Creek. Restoration of the lower Bear Creek floodplain is also very important to create additional adult holding habitat and a diversity of habitat types in an urbanized area. Redmond's RiverWalk project has provided some additional aquatic habitat; however, already completed sections and future planned sections should be evaluated to determine if more or different aquatic habitat features could

be added. There is at least one remnant oxbow or meander in this reach (on the right bank across from Willows Run) that could be reconnected to the river.

The primary limiting factors for salmon species in this reach of the river are elevated temperature and lack of a riparian area. Lack of floodplain connectivity and lack of cover are also limiting factors. Wildlife habitat is negligible in this reach, primarily due to the high level of human disturbance and habitat fragmentation. Wildlife habitat could be improved by restoring wetland habitat and the riparian area.

Reach 6 (RM 12.5 to 13.6)

This reach extends from the Bear Creek confluence to Lake Sammamish. Adjacent land use is almost entirely Marymoor Park, although residential areas are located just out of the floodplain on the left bank. West Lake Sammamish Parkway also borders the river for a portion of this reach. The vegetation in the riparian area is composed primarily of willow although the lower third of the reach is dominated by blackberry and reed canary grass. Instream habitat includes 22% riffles, 3% pools, and 75% glide habitat. This reach of the river provides the best existing physical habitat; however, elevated temperature is the most severe in this reach as a result of the warm Lake Sammamish outflow. The relatively long riffle (>1000 feet [303 m]) in the transition zone[11] is bordered on both banks by 60% willow and provides some of the only canopy cover along the entire mainstem. However, the riparian width here is still only 25 to 50 feet (7.5 to 15 m) wide for much of the reach, although the very upper end of the reach has a riparian area greater than 100 feet (30 m) wide. Coho and kokanee have been observed spawning in the transition area, although the substrate is primarily composed of quarry spalls. Jeanes and Hilgert (1999) also observed chinook and coho there, although not spawning, in 1999. Two unnamed tributaries enter this reach (0141 and 0142). Temperature in this reach can exceed 79°F (26°C) for brief periods in the summer and is typically above 73°F (23°C) (Corps unpublished data 1998 and 1999 used in the model in Appendix B). Historically, this entire reach was likely part of Lake Sammamish prior to construction of the locks. Where the lake meets the river, a significant amount of wetland area is still present on both riverbanks. Emergent, forested, and scrub-shrub wetlands provide a mosaic of habitats within the open space.

Key restoration opportunities in this reach include temperature reduction through modification of the Lake Sammamish outflow, riparian revegetation, reconnection of an old meander adjacent to the transition zone, and creation of cool water refuge by utilizing groundwater sources in the reach. Any mitigation that may be planned for this area should consider the key restoration needs and opportunities mentioned above.

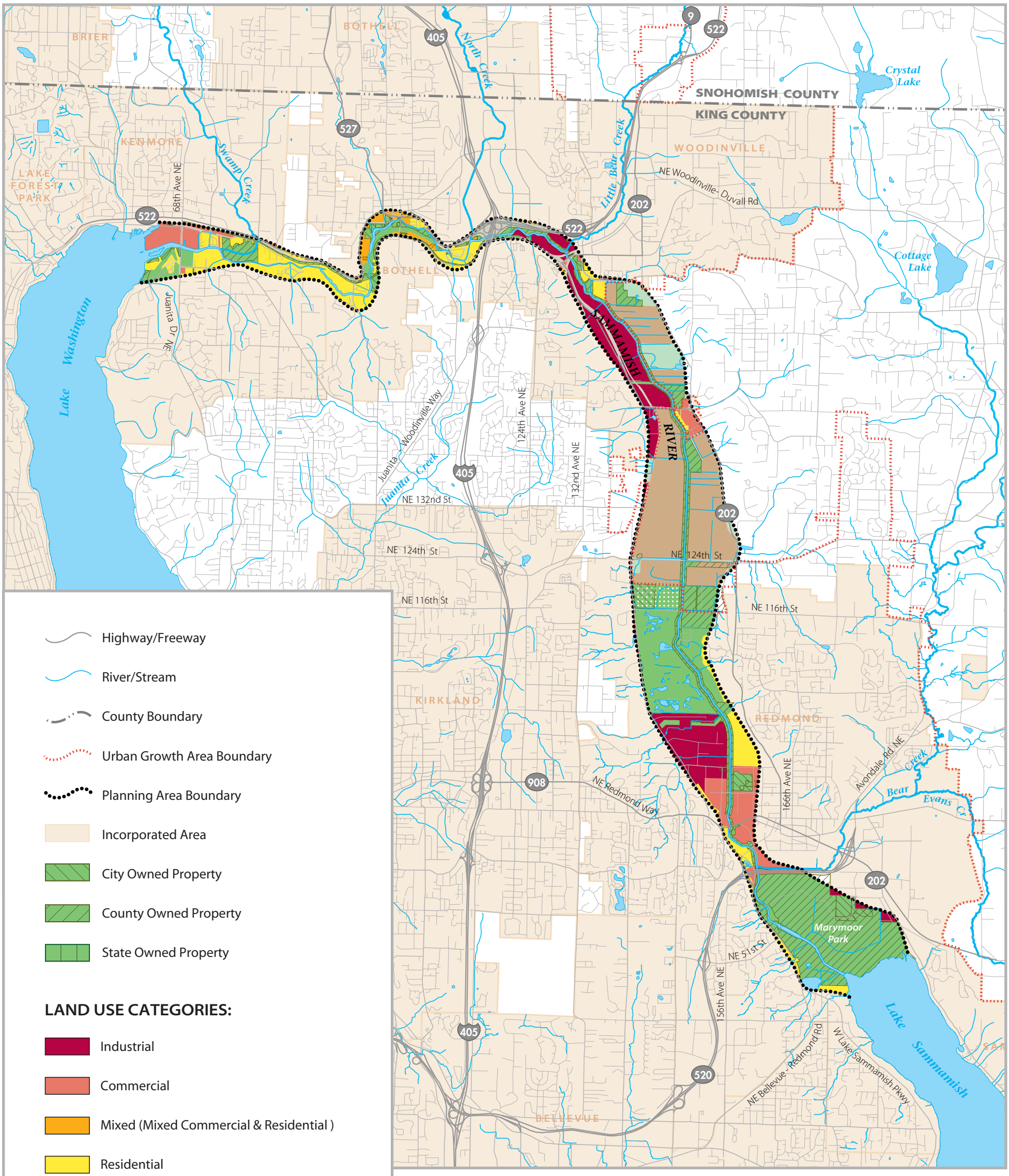
The primary limiting factor for salmon in this reach is elevated temperature, more than in any other reach. Other than water temperature, habitat is actually of moderate quality in this reach. Wildlife habitat is also in fairly good condition, but is limited by lack of sufficient migration corridors and potential effects of park uses such as the dog leash-free area, which may limit wildlife usage. Currently, the dog access locations along the river are fenced off during the salmon migration season, although there is limited evidence to show if dog presence inhibits fish migration upstream of the weir.

CONTINUED DEVELOPMENT

In 2000, the Sammamish River watershed population was approximately 410,000. King County estimates the population will grow to approximately 500,000 by 2010 and 580,000 by 2020, using growth projections from the Puget Sound Regional Council (C. Gaolach, King County, pers. comm. 2001). A majority of this increase is projected to occur in the Swamp and North Creek basins, which are almost entirely within the urban growth boundaries of King and Snohomish counties. Additional population growth will place further

[11] The transition zone is located downstream of the weir and was designed for the Corps/King County flood control project to be a transition between Lake Sammamish and the regular river channel. It is wider than all other areas of the river and is lined with quarry spalls to reduce erosion of the bed.

pressures on the already degraded Sammamish River Corridor. Additional forested areas may be cleared for housing and other development that could reduce buffers on streams and wetlands and development will increase impervious areas (which will increase winter runoff and reduce groundwater recharge). There will be an increased demand for water supply, which may be primarily provided from other subwatersheds (i.e. Cedar River, Tolt River), although proposals to utilize Lake Washington water as a potential drinking water source have been discussed. Overall, it will be important to minimize the degradation that could continue to occur as a result of population growth; otherwise, any restoration actions may just maintain existing conditions without effective improvements to the ecosystem.



- Highway/Freeway
- River/Stream
- County Boundary
- Urban Growth Area Boundary
- Planning Area Boundary
- Incorporated Area
- City Owned Property
- County Owned Property
- State Owned Property

LAND USE CATEGORIES:

- Industrial
- Commercial
- Mixed (Mixed Commercial & Residential)
- Residential
- Residential Rural
- Open Space/Recreation (includes Puget Power and Tolt River Right-of-Ways)
- Currently Open Space (Park) but under court review; may change to agricultural
- Agricultural
- Right-of-Way (Roads and Railroads)

NOTES:
Land use designations based on King County and local jurisdictions' current zoning data.

File Name:
LP WLRNT8/CART/FINISHED/...Samm/0208 SamAP_LU.eps

N

0 0.25 0.5 1.0

Miles

Figure 5

LAND USE

Sammamish River Basin

King County
Department of Natural Resources and Parks
Water and Land Resources Division
GIS and Visual Communications & Web Unit

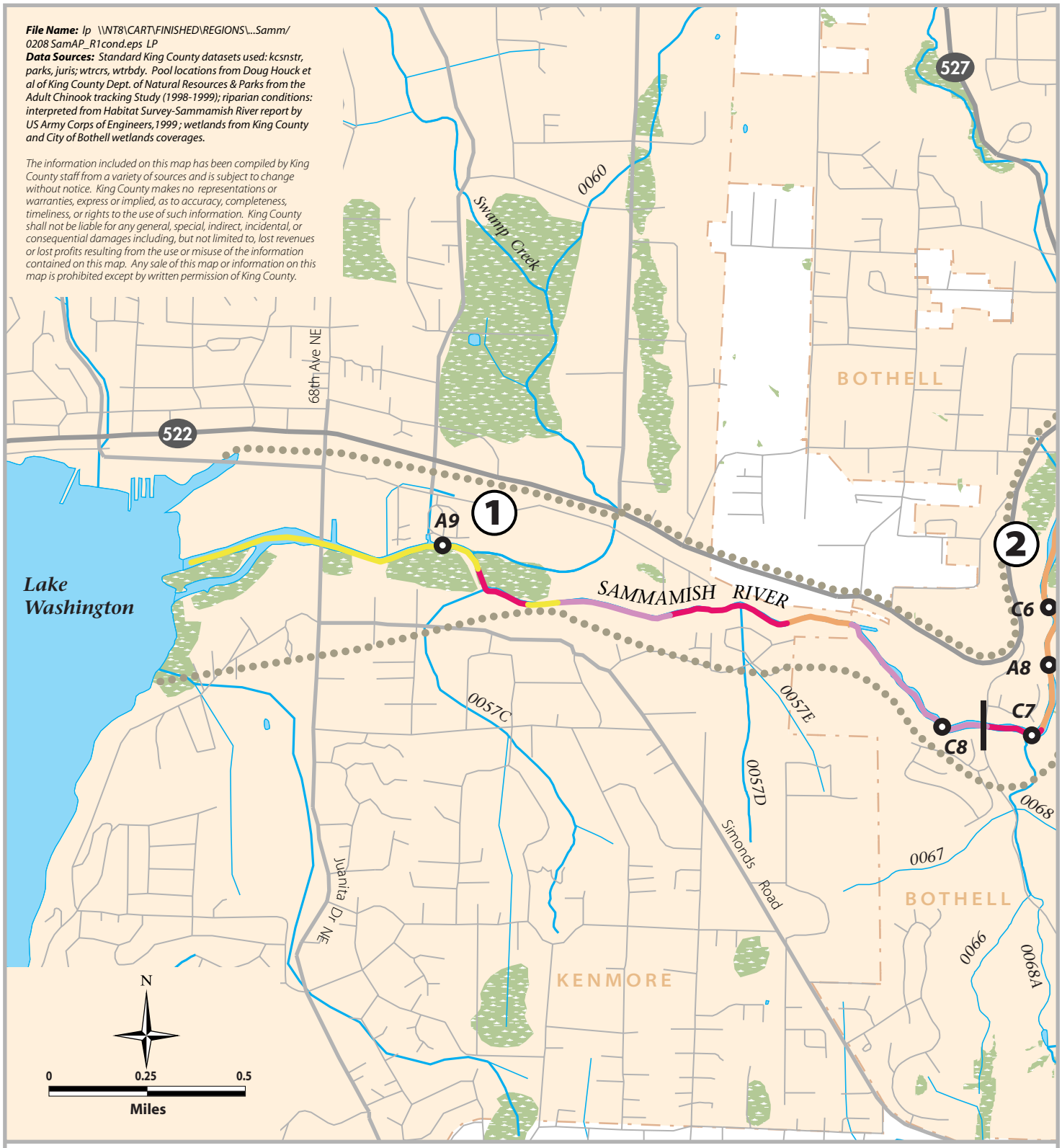


Figure 6

REACH 1
Existing Conditions

Sammamish River Corridor

King County
Department of Natural Resources and Parks
Water and Land Resources Division
GIS and Visual Communications & Web Unit

1 River Reach Number

River and Reach Boundary

Road

River/Stream

Planning Area Boundary

Wetland

Incorporated Area

A7 Pool Location & Number

RIPARIAN CONDITIONS

Forested Coniferous

Forested Deciduous

Non-native

Non-native Extreme

Scrub/Shrub

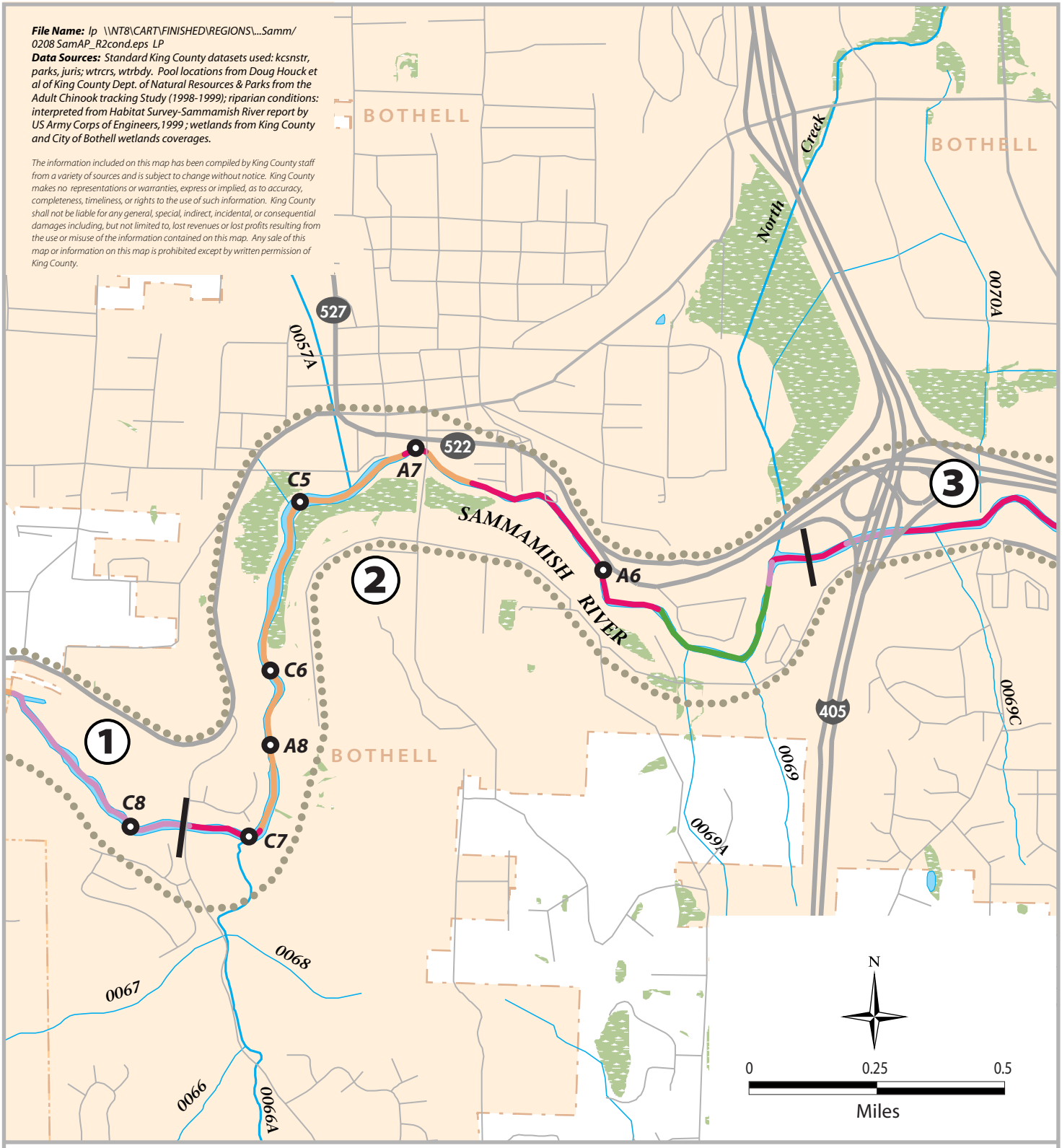


Figure 7

REACH 2
Existing Conditions

Sammamish River Corridor

King County
Department of Natural Resources and Parks
Water and Land Resources Division
GIS and Visual Communications & Web Unit

- River Reach Number
- River and Reach Boundary
- Road
- River/Stream
- Planning Area Boundary
- Wetland (from City of Bothell)
- Incorporated Area

- *A7* Pool Location & Number

RIPARIAN CONDITIONS

- Forested Coniferous
- Forested Deciduous
- Non-native
- Non-native Extreme
- Scrub/Shrub

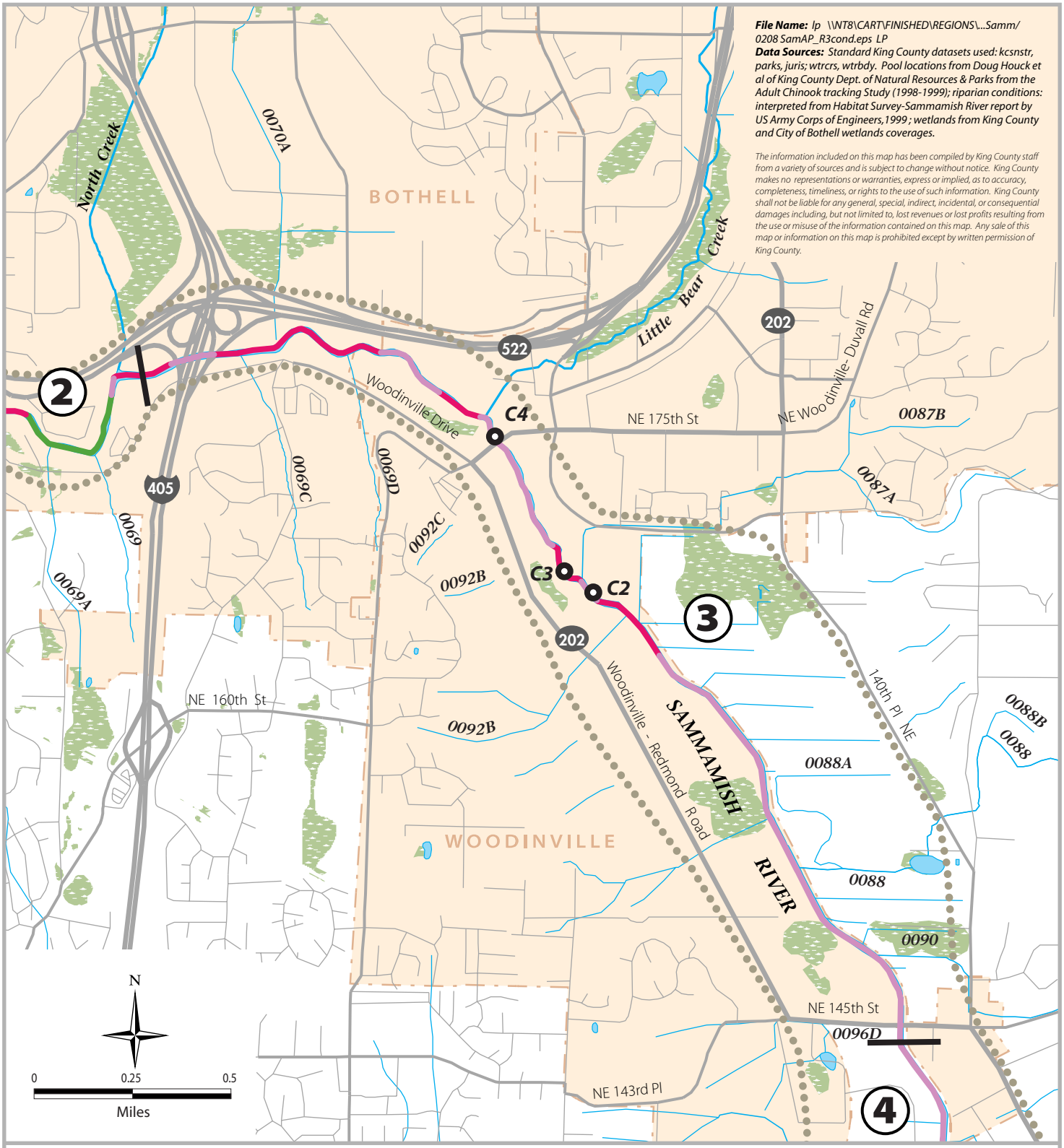


Figure 8

REACH 3
Existing Conditions

Sammamish River Corridor

King County
Department of Natural Resources and Parks
Water and Land Resources Division
GIS and Visual Communications & Web Unit

- River Reach Number
- River and Reach Boundary
- Road
- River/Stream
- Planning Area Boundary
- Wetland (from City of Bothell)
- Incorporated Area

A7 Pool Location & Number

RIPARIAN CONDITIONS
- Forested Coniferous
- Forested Deciduous
- Non-native
- Non-native Extreme
- Scrub/Shrub

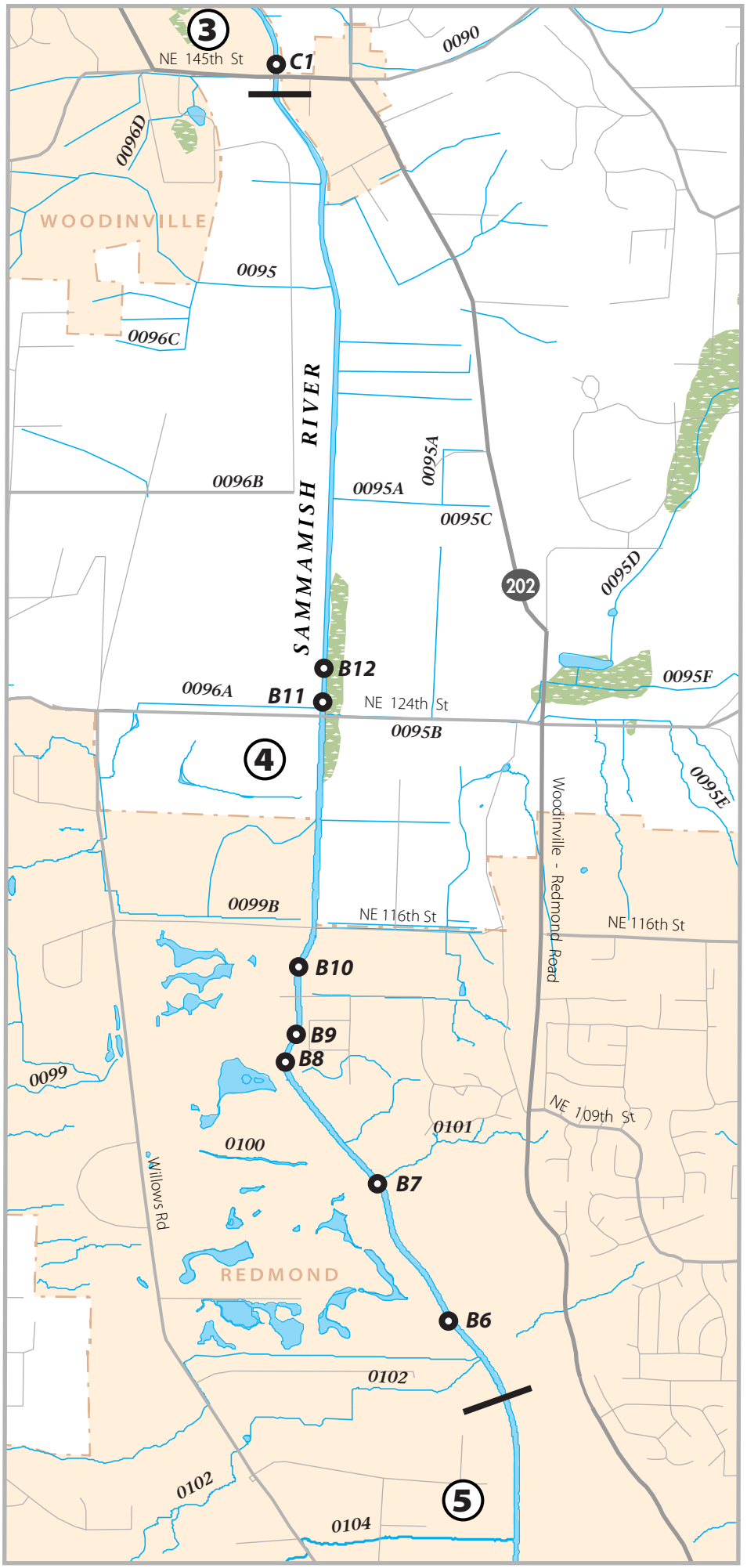


Figure 9

REACH 4
Existing Conditions

Sammamish River Corridor

- 1 River Reach Number
- River and Reach Boundary
- Road
- River/Stream
- Planning Area Boundary
- Wetland (from City of Bothell)
- Incorporated Area
- A7 Pool Location & Number

RIPARIAN CONDITIONS

- Forested Coniferous
- Forested Deciduous
- Non-native
- Non-native Extreme
- Scrub/Shrub

N

0 0.25 0.5

Miles

File Name: *lp \\NT8\CART\FINISHED\REGIONS\...Samm/0208 SamAP_R4cond.eps LP*

Data Sources: *Standard King County datasets used: kcsnstr, parks, juris; wtrcrs, wtrbdy. Pool locations from Doug Houck et al of King County Dept. of Natural Resources & Parks from the Adult Chinook tracking Study (1998-1999); riparian conditions: interpreted from Habitat Survey-Sammamish River report by US Army Corps of Engineers,1999 ; wetlands from King County and City of Bothell wetlands coverages.*

King County
Department of Natural Resources and Parks
Water and Land Resources Division
GIS and Visual Communications & Web Unit

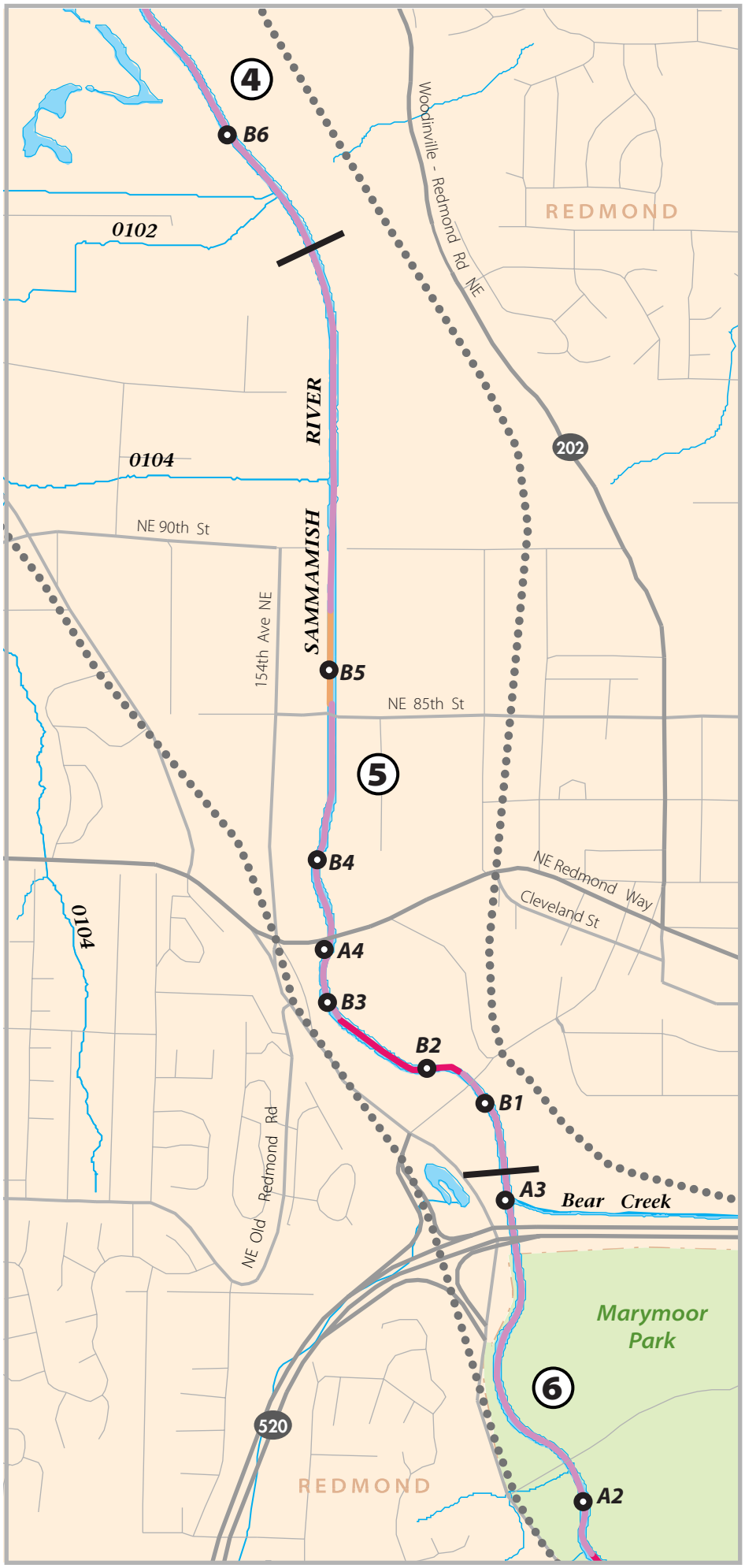


Figure 10

REACH 5
Existing Conditions

Sammamish River Corridor

- 1 River Reach Number
- River and Reach Boundary
- Road
- River/Stream
- Planning Area Boundary
- Park
- Incorporated Area
- A7 Pool Location & Number

RIPARIAN CONDITIONS

- Forested Coniferous
- Forested Deciduous
- Non-native
- Non-native Extreme
- Scrub/Shrub

N

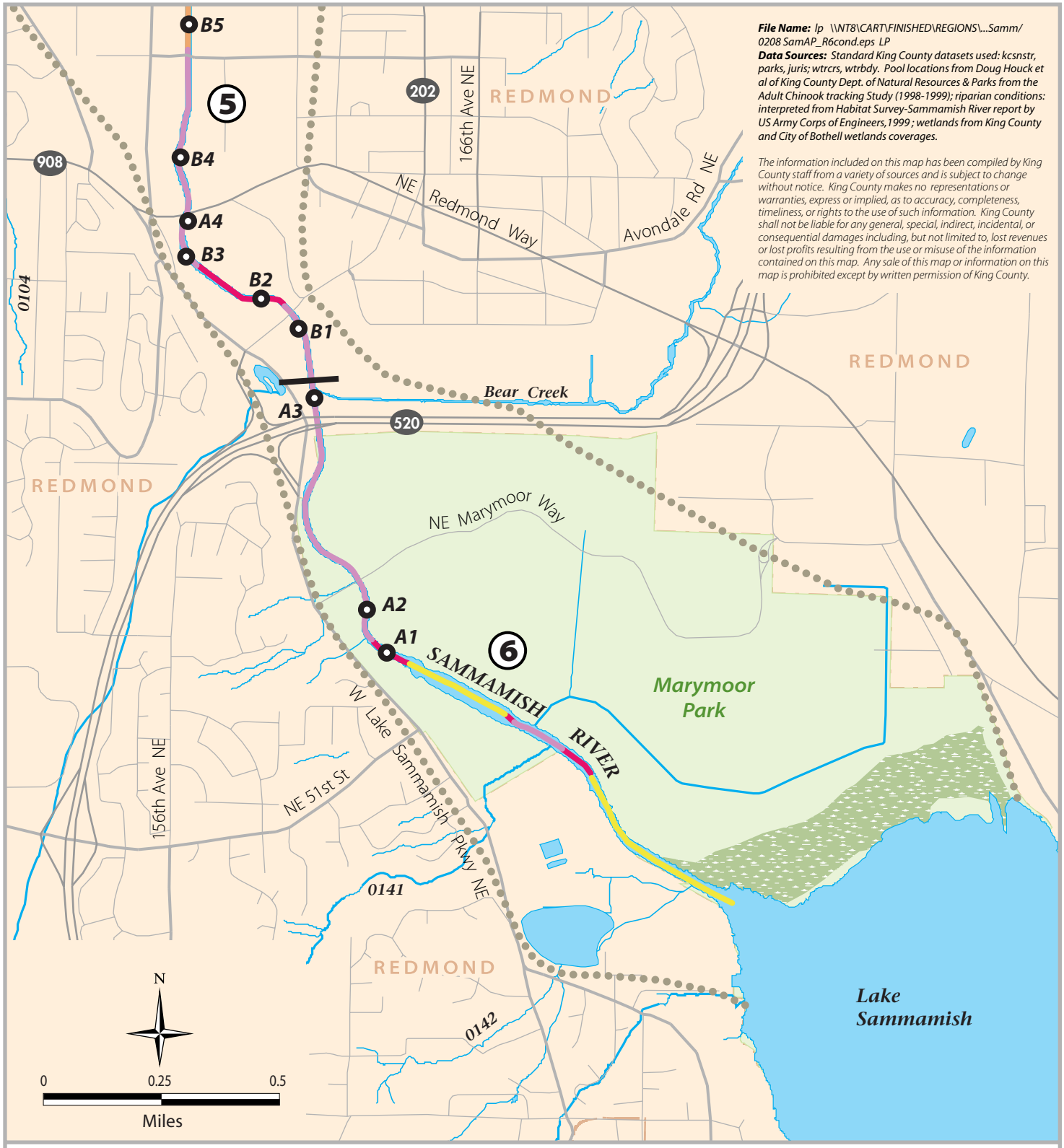
0 0.25 0.5

Miles

File Name: *lp \\NT8\CART\FINISHED\REGIONS\...Samm/0208 SamAP_R5cond.eps LP*

Data Sources: *Standard King County datasets used: kcsnstr, parks, juris; wtrcrs, wtrbdy. Pool locations from Doug Houck et al of King County Dept. of Natural Resources & Parks from the Adult Chinook tracking Study (1998-1999); riparian conditions: interpreted from Habitat Survey-Sammamish River report by US Army Corps of Engineers,1999 ; wetlands from King County and City of Bothell wetlands coverages.*

King County
Department of Natural Resources and Parks
Water and Land Resources Division
GIS and Visual Communications & Web Unit



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Data Sources: *Standard King County datasets used: kcsnstr, parks, juris; wtrcrs, wtrbdy. Pool locations from Doug Houck et al of King County Dept. of Natural Resources & Parks from the Adult Chinook tracking Study (1998-1999); riparian conditions: interpreted from Habitat Survey-Sammamish River report by US Army Corps of Engineers,1999 ; wetlands from King County and City of Bothell wetlands coverages.*

Figure 11

REACH 6
Existing Conditions

Sammamish River Corridor

King County
Department of Natural Resources and Parks
Water and Land Resources Division
GIS and Visual Communications & Web Unit

- River Reach Number
- River and Reach Boundary
- Road
- River/Stream
- Planning Area Boundary
- Park
- Wetland
- A7 Pool Location & Number
- Incorporated Area

RIPARIAN CONDITIONS

- Forested Coniferous
- Forested Deciduous
- Non-native
- Non-native Extreme
- Scrub/Shrub